A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. MCGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 87 — NEW YORK, JULY 7, 1921 — Number 1

Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally, *Engineering News*," under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally, to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The staff of *Engineering News-Record* consists of

New York: E. J. Mehren, *Editor;* F. C. Wight, *Managing Editor;* M. N. Baker, F. E. Schmitt, R. K. Tomlin, Jr., H. H. French and J. W. Shaver.

Chicago: W. W. DeBerard, E. E. R. Tratman, C. S. Hill.

San Francisco: N. A. Bowers.

Heating Rivets with Gas

Gas has certain obvious advantages over coke and oil and has replaced these fuels in many industries where there were no special obstacles to the use of gas. In the structural steel field, rivet heating is still done chiefly with oil or coke; gas does not seem to have found favor there. During the war shipyards of the Pacific Coast began to change over their rivet heaters from coke or oil to gas and in some districts gas became the preferred fuel for this service. This change, it appears, was not only for the emergency of war time as gas is continuing in service. The article in this issue by Letson Balliet claims greater economy and better rivets as a result of the conversion to gas in the shipyards of the San Francisco Bay region. Mr. Balliet was instrumental in bringing about this conversion, and it follows that he is an enthusiastic believer in the superiority of gas over oil and coke. While his point of view is to be taken as representative that of the industrial or efficiency engineer of the steel shipyard, the progressive structural engineer would do well to examine with an open mind the claims and reasons advanced, to see what may be worthy of consideration in the structural steel field.

What Is a Profession?

THERE NEEDS to be a clear definition of what constitutes a profession. Engineers have long regarded themselves as professional men. Now the general contractors style themselves in the same way, and the builders are claiming for themselves a professional status, for the National Association of Builders' Exchanges has just adopted a code of ethics in which it describes its members as being engaged in a profession. Obviously, law, engineering, contracting, and building, if professions, are professions in quite different senses. That the builders are not arrogating to themselves professional distinction without trying to erect standards to which their members should attain, it is worth noting that the code sets forth that the members are engaged in a calling "in which there is a well-defined duty and obligation toward the public and themselves. The profession demands that the members use every honorable means to uphold the dignity and honor of the same, to exalt its standards, and to extend its spirit of usefulness." Of course, a mere declaration of that sort is worthless unless backed up by disciplinary procedure, but certainly, even if one quarrels with the arrogation of the title "profession," one cannot but be gratified that the builders are taking at least the first small step toward raising the standards of their calling. The term "profession," however, certainly needs to be safeguarded, at least to the extent of working out an acceptable definition.

The Builders' Code

AS MIGHT be expected, the code adopted by the builders has not the finish of the codes of the learned professions. Possibly the character of the new code is best illustrated by the introduction clause which says, "We understand ethics to mean a declaration of principles." With such a beginning one might expect a confused sort of document. And so it is. Ethical considerations are strangely thrown in with mere rules aimed to serve the interests of its members. A professional status—whatever that is—may eventually come to the builder, but the heights are going to be mounted slowly and painfully.

Engineers and Railroads

APPOINTMENT of a board of six engineers to engage in work "regarded as an important step in the solution of the transportation problems now confronting the country" is a step in the right direction. This appointment has been made by the National Association of Owners of Railroad Securities in constituting the Board of Economics and Engineering. It is recognized that the great problem in transportation now is to reduce railroad operating expenses, and the announcement of the security owners association indicates that the new board will be charged with making recommendations to this end. It is also indicated that the board will study possibilities for effecting economies through the consolidation of railroad properties and the elimination of wasteful competitive practices. This association represents bondholding rather than stockholding interests. The bondholders feel justified in initiating action, believing that their investments are, or will be impaired. It is entirely problematical how far recommendations, however important, emanating from bondholding interests can go in accomplishing direct results until it is established that the bondholders' equities are actually endangered. However, the recommendations of this board of engineers should have weight not only

with the public but also with the railroad managements, since its members have the distinct advantage of being unhampered by individual financial interests. A few weeks ago this journal urged that railroad operating problems heretofore solved merely by rule of thumb should be given over to men equipped to solve them by accurate scientific methods—in other words, engineers. Not only is the appointment of six engineers on this new national board recognition of such a necessity, but it is recognition of the engineers' broader qualifications to deal with the larger phases of the problem. If the railroad managements—that is, the stockholding group—had made such a move, it would be all the more encouraging.

San Francisco Bay Bridge Schemes

THAT the San Francisco bay region seems now to be in earnest about a transbay bridge or tunnel is evident from the origin and variety of the independent plans reviewed in this issue. The enormous increases of automobile traffic in recent years on California's very extensive highway system has enlisted the powerful support of the ubiquitous motorist and Admiral Jayne's plan, with tentative sanction from Washington, opens up a new field of investigation by implying that the pier-head line need not be kept within the previous limits but that trestles well out into the bay from the Oakland side might be permitted. The plans originally proposed by John G. Little deserve special comment in that they are based on a very broad view of the whole situation. He began with a survey of the probable industrial development around the bay, and located crossings with industrial as well as physical considerations in mind so that the early construction will not be a lost investment when later growth calls for additional harbor or transportation facilities. He says "Some of these crossings may not be built in the next two hundred years; some of them may never be built at all, but several of them will surely be built within the next twenty years and the way should be kept clear for them and nothing should be constructed if avoidable at any of these natural crossing points that will interfere with the location as a bridge site." San Francisco certainly needs—and needs urgently—some form of direct communication with the east bay shore and the time for action in securing a bridge or tunnel seems to have arrived. Not only would this relieve a traffic condition that is now a serious handicap, but it would hasten the much needed union of San Francisco bay cities into a harmonious unit.

Engineers Prepare Court Case

In court proceedings which involve judgment of engineering evidence, engineers have frequently an educational duty which can well go beyond the stage to which it is usually carried. Unusual perception of this fact is apparent in the methods employed by the engineers of the Milwaukee Sewerage Commission in the damage suit involved in the construction of the sewer tunnels described on page 4. Two purposes were kept in mind by the engineers who prepared the case. One was to instruct the city attorney in the engineering fundamentals of the dispute and the other was to make the technical facts and reasoning plain to judge and jurymen. The methods are described in the article. They emphasize the use of models. The function of these models was to reduce engineering technicalities to terms which the non-technical juryman could readily understand. A vital contention of the contractor was that the soil penetrated by the tunnel was unstable to a degree which endangered the tunnel structure. This claim was supported by descriptive evidence and an exhibition of samples. Rebutting evidence of similar character simply left the jury confused in a maze of poorly comprehended contrary statements. A model of the excavation showing the simple roof-timbering and the enlarging of the invert without, or with only very little, timbering, swept aside all confusion. It was within the comprehension of any juryman that a material which could be as easily managed as the model indicated was not particularly unstable and certainly not a menace to the safety of the tunnel structure. His decision was, therefore, prompt and reckoned little of soil analysis or expert testimony.

"High-Salaried Engineers"

IN AN appreciation of the late A. G. Batchelder one of the editors of the *American Motorist* remarks that that good-road enthusiast was more pleased at the passage of the first federal-aid road bill than "any one of the highway engineers, who have gained important and high-salaried positions by the creation of the fund." Possibly this is only a hastily considered comment, but it comes with poor grace from one who should know the highway situation thoroughly. Anyone so close to the good-roads movement should know how ridiculously small are the salaries paid the federal highway officials.

Liberal Courses as a Prerequisite for Engineering

PROFESSOR BURR has given the engineering educators of the country something to think about through his interesting paper at New Haven, in which he challenged the character of the society's activities and maintained that engineering would be accorded its proper place in public esteem only when a liberal education—or at least three years of it—is made prerequisite to an engineering course.

On the past activities of the society we offer but little comment. If the New Haven meeting be typical, we should say that a shaking up is desirable. The meeting was drab; there was little of broad vision, nothing to send the teacher away with new inspiration and enthusiasm. It would suffer much by comparison with the yearly conventions of half a dozen organizations in the civil-engineering field. But decision as to the justice of Prof. Burr's criticism of the activities of the society must be left to those who know it.

His other point is more important. No one will deny that we need a greater number of engineers with a broad outlook, but there will not be agreement that the standard engineering course should be one requiring a liberal education as a prerequisite. Colleges surely should lay out, for those who want them, six-year courses leading to two degrees. In fact, they may well go farther and urge such courses as desirable; there should be enthusiasm for them, and an appreciation of the excellent preparation they give for a rich life work. For the present, though, that is as far as most institutions dare go; nor is the reason solely that their prospective students want to be turned into engi-

neers in four years. There is legitimate reason to question whether the profession does not have places for a great many who are not qualified for six-year courses, but can in four years be excellently trained for their places in the engineering world. If that be the case it would be against the interests of the profession to force all collegiate work in engineering to what would be graduate, or, as Prof. Burr terms it, "professional" grade.

There is another necessary inquiry regarding Prof. Burr's argument. Much that he said depended, consciously or unconsciously, on the thesis that engineering can be made to occupy in public esteem a position equal to that of law and medicine. We doubt that that thesis can be demonstrated as sound. The conditions surrounding law and medicine, on the one hand, and engineering, on the other, are radically different. Only a small minority, less than 10 per cent of the engineering profession (those, namely, in consulting practice) are on a plane comparable with the doctor or the lawyer. It is a precious minority—a very precious one, indeed—but, unfortunately, it is not large enough to give the truly professional color to the whole of engineering practice.

Prof. Burr's paper deserves the consideration not merely of the teachers but of practicing engineers, as well. The latter, let us hope, will jump in and say their say quickly. The teachers—if the action of the convention be strictly interpreted—are not expected to have thoughts thereon until next June.

Waiting for Scientific Discoveries

SHALL needed public works be held up pending the possible discovery of future scientific improvements of the art? An affirmative answer would effectively stop all impending present-day construction, for there are few lines of engineering today that are not constantly being broadened, extended and changed to take advantage of newly found scientific laws. Illustrative of this point and of the difficulties through which many a city must pass on its way toward obtaining public improvements is the experience of Milwaukee. Politics and engineering, personalities and chemistry, local feeling and high-grade scientific discovery have been important factors for the past several years in the controversy over the relative importance of sewage and water treatment. Rash is the engineer or the scientist who engages in a controversy of this kind without first learning all of the factors in the case in hand, besides taking into account other needs of the city.

Ten years ago Milwaukee called three consulting engineers—H. P. Eddy, G. C. Whipple and John W. Alvord—to report on sewage disposal. These almost went out of their way to say that water filtration was the first line of defense, although advising that both water and sewage treatment were essential. Politically, the city has for some years past been divided between socialists and non-partisans, as the opposition to the socialists is called. The non-partisans advocated sewage treatment and the socialists sponsored water filtration. For two years nothing was done. Then the non-partisans, being in power, obtained the passage of a bill in the State legislature creating the present Sewage Commission for the definite purpose of building sewage-works but no provision was made for water filtration. No doubt the sustaining force behind the sewage movement was the conviction on the part of the general public that sewage treatment would solve the water problem, at least for a number of years. Then ensued the long line of sewage experiments to produce non-polluting effluent. A change in administration, and an unusual pollution of the water by phenol by-products, rendering the water almost unusable if safely chlorinated, brought water treatment again to the front at a time when its political supporters were in power. A technical report by J. W. Ellms, consulting engineer, based on investigations for a year, indicated that the water, even after treatment of the sawage, would not be safe. He recommended immediate filtration.

When plans were well started questions arose as to cost. Then came a report from a committee of the local section of the American Chemical Society. In effect it says that filtration should not be started because present-day filtration methods are in all probability antiquated and because within a few years, by taking advantage of new discoveries in colloidal chemistry and adjusting the hydrogen-ion concentration, vastly improved filtration methods will be developed. Politically some say, and scientifically others aver, this report by the chemists was not pleasing to the socialists. However that may be, Harrison P. Eddy, who for several years has been employed by the Milwaukee Sewerage Commission as consulting engineer, was called in to advise on water treatment. His report, abstracted elsewhere, may be considered the last word on the subject. As noted, he counsels an immediate start on plans for water treatment and simultaneously further experiments along the lines suggested by the chemists. He is not optimistic of the attainment of the far-reaching results the chemists predict. In his opinion any change in design suggested by further chemical studies will not be material and can be made quickly.

A decidedly new angle is presented in this argument of the chemists for deferment—an argument, if accepted as valid, that would be perfectly effective in stopping work on any filtration project in the country. Such an argument for a halting policy has rarely if ever been brought forward seriously in an important engineering matter. Because of its nature and because of its being brought forward by men without experience in water treatment, it must inevitably arouse decided objections on the part of sanitary engineers, men who have given their whole careers to the study of the very subjects into which the chemists lightly leap. How lightly the Milwaukee chemists took this leap is illustrated by their apparent oversight or at least ignoring of the fact that Mr. Ellms is himself a chemist of many years' standing, having been, after and besides other engagements, continuously connected with water treatment at Cincinnati, Cleveland and elsewhere for the past 23 years, serving at Cincinnati successively as assistant chemist, chemist, and superintendent of filtration. Moreover, Mr. Ellms, as already mentioned, directed water-treatment experiments at Milwaukee, on the very water in question, during which chemical and bacterial studies were conducted under his direction. Thus in their haste or zeal to promote chemical service, the Milwaukee chemists seem to have overreached.

Finally, although Mr. Eddy's conclusions seem to offer a practical and harmonious way out of the Milwaukee complication, yet in another case involving inter-professional claims the solution might not be so happy.

Recovery of Flooded Sewer Tunnels at Milwaukee

Settling Shafts Carried Down Adjacent Lining, Opened Construction Joints and Flooded Tunnels—Contractual Difficulties Lead to Court Adjudication of Case

AN EVENTFUL engineering operation, which normally should have been without incident, has been concluded by the completion of two sewer tunnels under the harbor entrance at Milwaukee, Wis. The natural difficulties were not unusual and the tunnels were not large. However, the work failed when near completion, and had to be recovered and restored, and finally it came before the Federal Court for review and adjudication. Questions of construction methods, engineering design, default of agreement, damages and contractual responsibilities came up for consideration and decision.

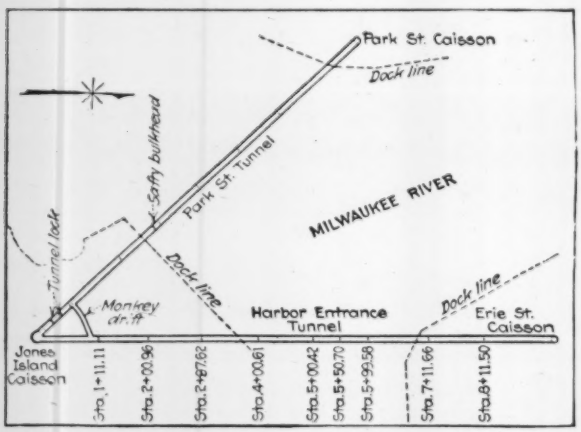


FIG. 1. CONSTRUCTION PLAN OF SHAFTS AND TUNNELS

Two subaqueous tunnels form the connecting link between the new intercepting sewer system on the mainland and the sewage works being constructed on Jones Island at Milwaukee. They constitute two reinforced-concrete inverted siphons, with separate drop shafts on the city shore (see the location plan, Fig. 1) and a common riser shaft on Jones Island. Both the shafts and the tunnels are of two-compartment construction as indicated by the drawings (see Fig. 5 and Fig. 9). Briefly, the Park St. siphon is 797.85 ft. long and 8 ft. in diameter inside, while the Harbor Entrance siphon is 937.42 ft. long and 8 ft. 9 in. in diameter. Originally the tunnels were designed circular, the anticipation being that they would be constructed by shields. The outside form was changed to that shown by Fig. 5, at the request of the contractor, when he decided to use timbering methods.

Original Construction and Failure

The general plan of construction adopted by the contractor was to sink the Jones Island shaft and from it to drive both tunnels toward the drop shafts, which meanwhile would be sunk ready for the junction. Broadly, separate operations of shaft sinking and of tunnel driving were planned.

Shaft Construction—All shafts were constructed as open caissons. In each case an excavation a few feet deep was made, at the bottom of which a cutting edge of the required diameter was started. The earth was then excavated inside this cutting edge with a clamshell, the caisson sinking of its own or under added loading. As soon as water began to come into the caisson, pumps were installed and the water was lowered from time to time, with the idea that the reduction in buoyancy would increase the effective weight of the caisson and that a current of water would be created downward outside the shell which would reduce the skin friction and would also erode the earth under the cutting edge and so assist the sinking. From time to time sections were cast on top until full depth was reached; then the water was allowed to come to its level and the bottom was closed with concrete placed under water.

As indicated by the sinking charts Figs. 2 to 4, the operation was reasonably rapid and regular except in the case of the Park St. shaft. Here a double caisson was employed, the idea being to obtain a caisson structure corresponding more closely than a single shell to the planned shape of the drop shaft. As indicated by Fig. 3, sinking proceeded normally with the outer caisson, until July 25, when the structure ceased to settle. Various means to induce movement, including undermining, water jets, loading and hammering, were tried. Finally a superimposed load in excess of 35 tons started the caisson on Aug. 18 and it settled about 3 ft.

Preparations were made to start the second caisson. Until it reached elevation —40 the small caisson settled normally but then the outer caisson began also to settle. The cause, it was thought, was that material was boiling in at the bottom, and to stop this action the inner caisson was loaded in an attempt to drive the cutting edge far enough below the excavation to provide a seal. This effect was not realized and the inner caisson proceeded, pulling the outer caisson with it, until grade was reached. Then the bottom of the inner caisson was plugged with concrete, the water was pumped down and the seal between the two caissons was constructed.

Sealing the Shafts—In plugging the caissons the bottoms of the pits were as the clamshell left them. At Jones Island and Park St. an open-top bottom-dump bucket was used to place the concrete, care being taken to lower the bucket through the water and well to the bottom before the concrete was dumped. When the caissons were unwatered the seals were found reasonably solid and tight. At the Erie St. caisson less care was taken. The concrete was placed with a clamshell, wide at the top, very shallow compared with a bucket, and also permitting excessive leakage. Also, it is stated, frequent batches were dumped well above the bottom so that the concrete fell through water.

As shown by the charts, the caissons were completed at different dates. The Jones Island caisson was unwatered on July 31, 1916, shortly after completion, to permit the tunnel headings to be started. Neither of the other caissons was intended to be unwatered until the tunnels were completed to junctions with them. The Erie St. caisson was the first to be laid dry, on Sept. 4, 1917. Then the tunnels had been completed, the monkey drift (Fig. 1) sealed and the air pressure removed. Cutting of the Jones Island shaft-eye into the Harbor Entrance tunnel was in progress. The Erie St. caisson had been laid dry to cut that shaft-eye into

the tunnel. On the date stated, at 1 p.m., while the bottom was being cleaned, a leak appeared, followed by others which drove the men out of the shaft. Soon afterward the shaft was flooded and the men were called out of the tunnels. By 4:30 p.m., shafts and tunnels were flooded. Measurements showed that the caisson had sunk 6 in., cracks appeared in the ground around the caisson and adjacent structures had settled. About 60 ft. of the adjacent tunnel had been carried down by the sinking caisson and this settlement had opened cracks in the linings, as described later, through which the water had entered to flood the tunnels.

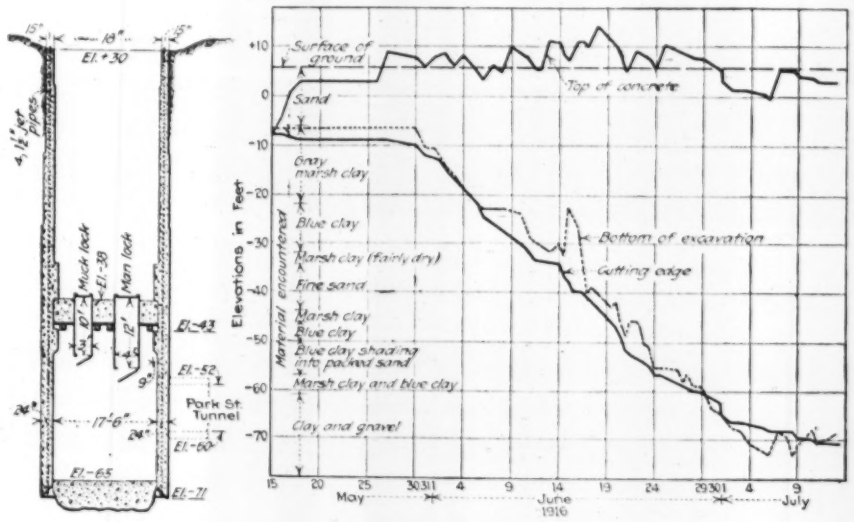


FIG. 2. JONES ISLAND CAISSON AND SINKING CHART

Tunnel Construction—Tunnel construction up to the time of the flooding involved comparatively few real difficulties. In general, the plan was to drive the Park St. tunnel about 100 ft. ahead from the Jones Island shafts, remove the shaft locks and place a tunnel lock, then drive a cross- or monkey-drift to the Harbor Entrance tunnel, and then proceed with both tunnels simultaneously. Until the tunnel lock could be built, air locks, as indicated by Fig. 2, were placed in the caisson. These shaft locks were removed as soon as the tunnel lock was in operation. A timbering method as indicated by Fig. 5 was adopted. Briefly, a top heading held by batter posts and crown plank was driven 10 to 12 ft. The face was then lagged, if the ground was soft, and the invert cut was made and concreted in 6-ft. sections, the concrete being placed as quickly as possible after the excavation was ready. On top of the invert steel forms were set up, and the roof arch was concreted in 6-ft. lengths. The partition slab was concreted separately after the lining proper was completed.

As stated, no particular difficulties were experienced. At places running soil required close watching, but it was always held by ordinary methods. Never was the general method of procedure, which required a fairly stable soil, abandoned. There were faults in workmanship, slight irregularities in line and grade, porous spots and poor construction joints, but these faults were not vital. They were most common in the Harbor Entrance tunnel. Nowhere did they show up particularly until the air pressure was removed. The sequence of work was somewhat erratic but generally the progress was rapid. With tunneling started late in August, 1916, both tunnels were holed through and lined, and arrangements were being made to remove the air pressure by May 31, 1917.

With the gradual release of the air pressure, leaks

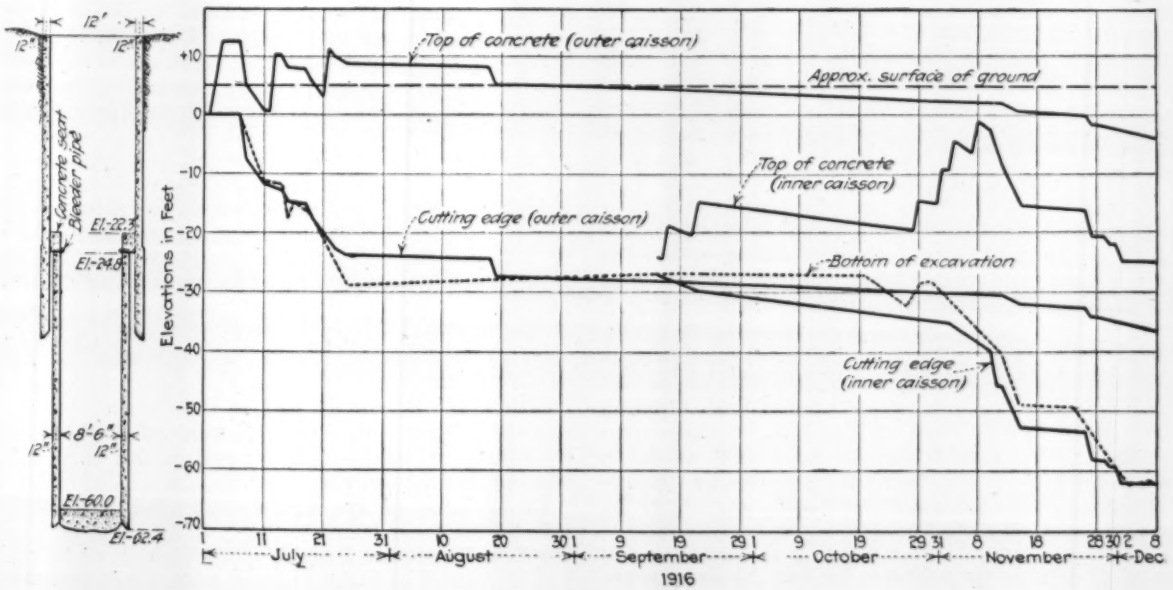


FIG. 3. PARK ST. CAISSON AND SINKING CHART

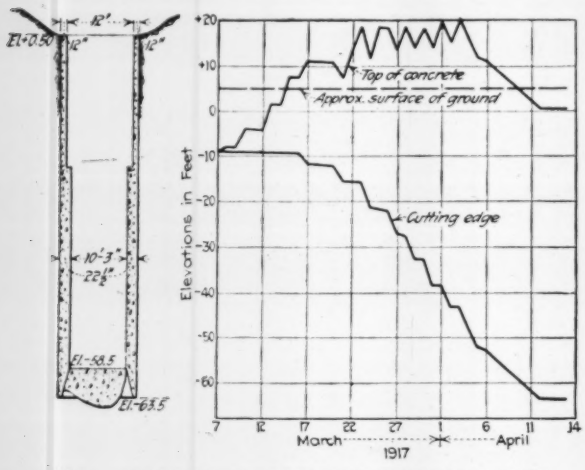


FIG. 4. ERIE ST. CAISSON AND SINKING CHART

appeared. These were insignificant in the Park St. tunnel and will not be considered further. In the Harbor Entrance tunnel, however, on June 2, with the air pressure at 13 lb. (it ran from 20 to 32 lb. during construction), several construction joints were leaking a spray like a shower bath, and at station 1 + 50 (see Fig. 1) there was a ¼ x 1½-in. stream. On June 3, with the pressure at zero, so much water was entering the tunnel that air pressure was restored. With the tunnel freed of water an examination on June 6 showed a ⅛-in. roof crack at station 6 + 85 and several smaller roof cracks, all at construction joints. There was a slab crack at 7 + 33 and a bottom crack at 7 + 36, both open about ⅛ in.

There followed a period of delay and marking time. Work was not discontinued but no thoroughgoing effort was made to make the tunnel watertight, the position of the contractor being that this should be requisitioned as extra work, which the engineers of the sewerage commission declined to consider. Some of the cracks were chiseled out for filling, but they were not filled. Some porous spots were plastered, and home-made grout pads were tried out in a few places. One crack at the junction of the lining with the Erie St. caisson was thoroughly grouted. Meanwhile the contractor made surveys inside the tunnel and took samples of the concrete and of the ground behind the lining, in preparation, apparently, to substantiate his indicated claim that the lining defects were due to settlement because of inadequate design.

With the conditions about as indicated the contractor began on Aug. 8 to reduce the air pressure, which was at 24 lb. On Aug. 15 the pressure was zero. As the pressure was removed, leaking appeared, increasing as the pressure decreased. No sand came into the tunnel, and two 2-in. Cameron pumps handled the water. With the tunnel in free air, removal of the locks and delayed slab construction proceeded, and construction of the shaft-eyes was begun as previously described, when, on Sept. 4, the Erie St. shaft settled and the works were flooded. On Oct. 3, after due notice, the work was taken out of the contractor's hands by the sewerage commission and Oct. 24, 1917, a new contract was let for its recovery and completion.

In general the plan of recovering the work was to place air decks in the caissons; restore the air pressure and clear the work of water and earth; restore the defective structure to as nearly as possible the planned construction; close the leaks, and complete the structures as planned.

Reconstruction was begun at the Erie St. shaft. The caisson contained a layer of earth which had flowed in at the time of the accident. On this earth fill, 6 ft. of lean concrete was deposited through the water and then about 19 ft. of earth. Upon starting the pumps it was found that very little water entered through the plug, so the water was pumped down and the air deck placed. This air deck was provided with locks and loaded to resist upward air pressures.

With the air pressure on, the material in the caisson was excavated. Below the lean concrete there was about 6 to 8 ft. of mud which represented the material which had come into the caisson at the time of the accident. When this mud was cleared away the original concrete plug was found intact and hard. There were, however,

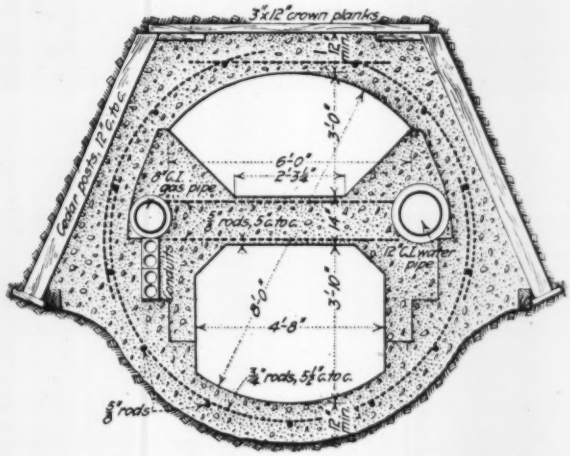


FIG. 5. SECTION OF PARK ST. TUNNEL AND TIMBERING

two places near the wall through which a bar could be thrust into soft ground, and when the air pressure was reduced slightly water came in at these places, showing conclusively that it was here that the water and earth entered. In cutting down the concrete it was found that the openings increased. The condition is indicated by the drawings of Fig. 6. Apparently, in excavating with the clamshell, the ground had been cupped out and the concrete did not fully seal the caisson. The concrete was cut down to about the level *AA* in Fig. 6 and a reinforced concrete floor 2 ft. thick was constructed. The Jones Island caisson was recovered by a similar procedure. Fig. 7 indicates clearly the methods, the original construction being indicated in this illustration by the cross-hatched sections. With the Erie St. and Jones Island caissons recovered the tunnels could be put under air pressure and cleared of water.

The condition of the Harbor Entrance tunnel on recovery is shown by Fig. 6. There were about 237 cu.yd. of material in the tunnel. About 259 cu.yd., including the amount of dirt in the Erie St. caisson, was estimated to represent earth displaced from around the tunnel and shaft. The removal of this earth was accomplished by ordinary methods.

Examination of the tunnel shell showed it to be intact from Jones Island to Sta. 8 + 59, or 75 ft. from the Erie St. shaft. From 8 + 59 to 9 + 04.5 there was a crack at each construction joint, varying from a hair crack to ⅛-in. width. At 9 + 04.5, 30 ft. from the

Erie St. shaft, the crack was 3 in. wide at the top of the arch and there was a vertical slip of about ¾ in. At the junction with the Erie St. caisson the arch was crushed as if by compression parallel to the tunnel. Elevations showed no settlement to Sta. 8 + 85, but thence to the caisson, 49 ft., the shell had tilted down so that at the caisson it was 16 in. lower than originally constructed. There were no longitudinal cracks and no signs of crushing other than indicated. The drawing, Fig. 6, shows the various conditions described; Fig. 8 is a view of the large roof crack at Sta. 9 + 04.5.

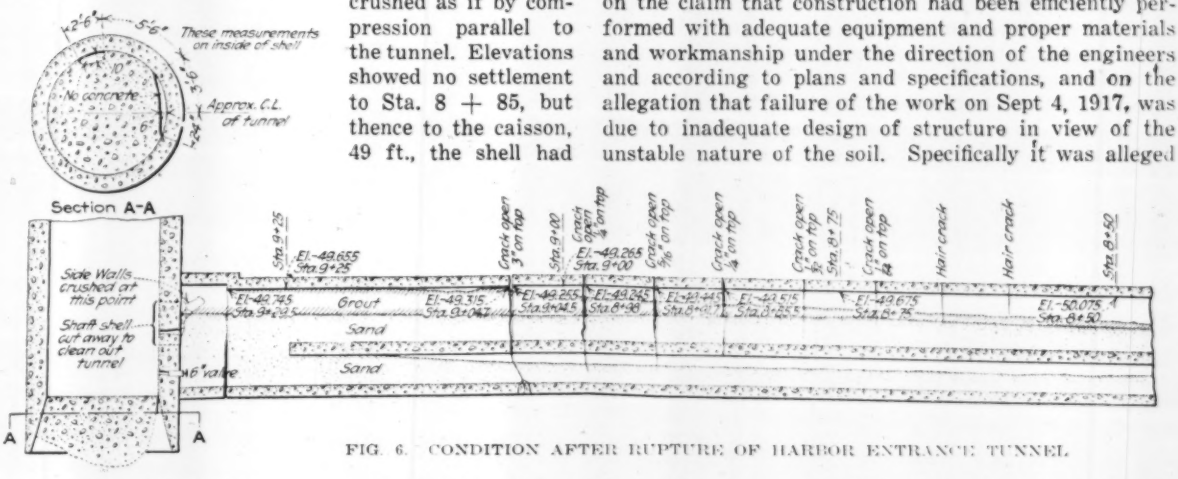


FIG. 6. CONDITION AFTER RUPTURE OF HARBOR ENTRANCE TUNNEL

The method of restoring the damaged section is indicated by Fig. 9. The settled bottom was filled up to grade and the slab was removed and built at the planned level. The roof was not changed. This construction restored the bottom conduit to its planned dimensions but constricted the top conduit for a short distance, which was considered less objectionable than risking the danger and expense of rebuilding the roof. As the settled section was reconstructed the cracks were closed by grouting. Following the restoration of the Harbor Entrance tunnel, the recovery of the Park St. shaft and the completion of shafts and tunnels involved no unusual methods. All work was performed with great caution but no unexpected difficulties were encountered. The cost of recovery and reconstruction is given in Table I. Since its completion in 1918 the structure has stood unimpaired.

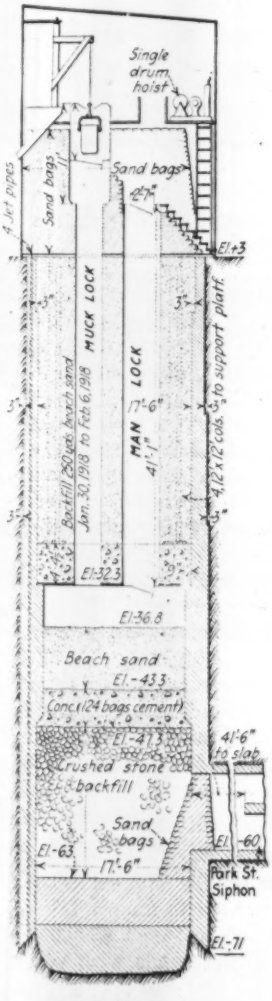


FIG. 7.
METHOD OF RECOVERING JONES ISLAND SHAFT

Tunnel Models Win Law Suit.—In March, 1918, suit was brought by the original contractors to recover $111,274, this being the balance of $239,689 expended on the work less payments received. The demand was made on the claim that construction had been efficiently performed with adequate equipment and proper materials and workmanship under the direction of the engineers and according to plans and specifications, and on the allegation that failure of the work on Sept 4, 1917, was due to inadequate design of structure in view of the unstable nature of the soil. Specifically it was alleged "that said plans and specifications did not provide for sufficient or proper bearing areas, sufficient quantity of concrete, proper mixture of concrete or sufficient or proper reinforcing."

In reply the sewerage commission denied both claim and allegation of the contractor and brought counterclaim for delay damages, and cost of completing the work in excess of the contract prices, on the allegation that the contractor "used faulty inadequate methods in the construction of the so-called Erie St. shaft, causing great damage and subsequent loss of the entire work."

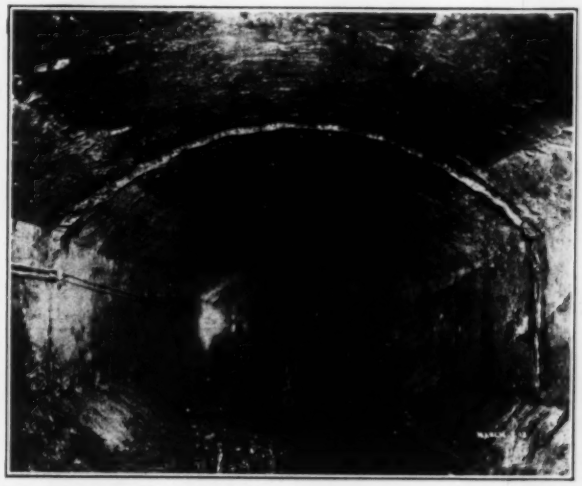


FIG. 8. VIEW OF LARGE CRACK IN TUNNEL ROOF

The verdict of the jury under instructions was in favor of the commission; the commission was awarded damages of $10,000, which, with the retained percentage, made a judgment of about $85,000 in its favor. Broadly the decision required was between (1) the contention of the contractor that inherent weakness of design caused the tunnel structure to settle, producing incidentally the settlement of the Erie St. shaft, and (2) the contention of the commission that improper methods of constructing the Erie St. shaft caused it to settle and carry with it an adjacent section of the tunnel structure.

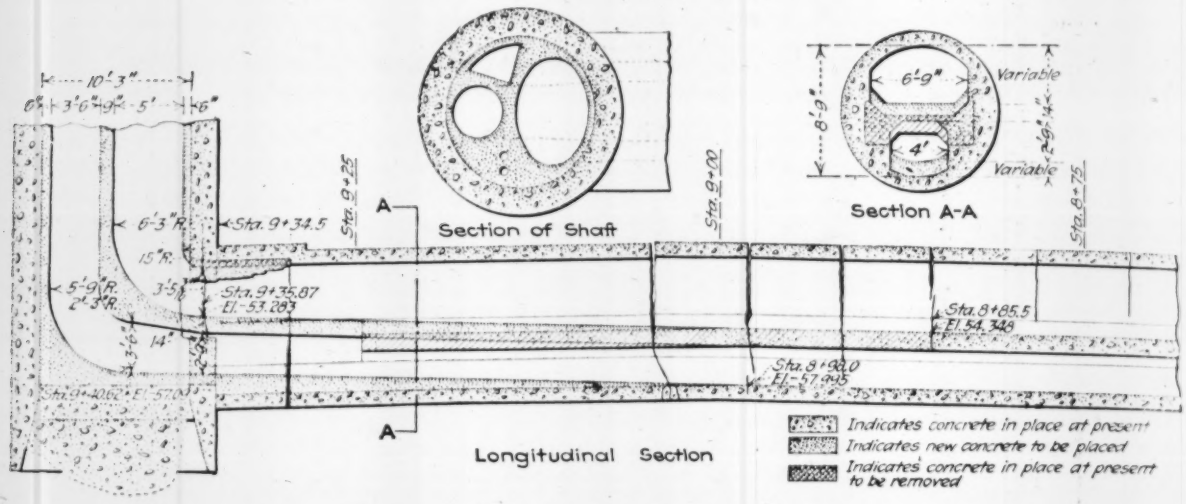


FIG. 9. RECONSTRUCTION OF DISPLACED PORTION OF HARBOR ENTRANCE TUNNEL

Both contentions involved the difficult task of making clear to a jury of laymen numerous unfamiliar technical facts and their significance under complex conditions. In this respect the preparation of the case for the city attorney by the engineers of the commission was the outstanding and suggestive feature of the court proceedings.

First a descriptive history of the work was prepared by the division engineer in direct charge. This included the original plans and contract, allowed changes in plans, progress charts and all facts of plant, methods and workmanship and all records of the loss and recovery of the work. It was indexed, and included precise reference to all original records of proof.

TABLE I. ANALYSIS OF COST OF WORK ON CONTRACT 25 FROM FIGURES AVAILABLE OCT. 22, 1918

	Recovery	Repairs	Completion	Total Cost
Erie St. Shaft:				
Labor	$8,027.56	$738.01	$6,105.58	$14,871.15
Plant rental	1,402.18	156.03	855.82	2,414.03
Material	6,382.90	40.43	3,171.41	9,594.74
Total	$15,812.64	$934.47	$10,132.81	$26,879.92
Jones Island Shaft:				
Labor	11,035.15	4.05	5,679.91	16,719.11
Plant rental	765.80	.14	711.20	1,477.14
Material	8,691.94	.22	2,389.34	11,081.50
Total	$20,492.89	$4.41	$8,780.45	$29,277.75
Park St. Shaft:				
Labor	.....	.....	7,018.21	7,018.21
Plant rental	.....	.....	867.51	867.51
Material	.....	.....	6,073.28	6,073.28
Total	.....	.....	$13,959.00	$13,959.00
Harbor Entrance Tunnel:				
Labor	9,429.80	2,743.23	1,624.29	13,797.32
Plant rental	1,991.77	568.78	379.18	2,939.73
Material	2,623.32	220.49	875.93	3,719.74
Total	$14,044.89	$3,532.50	$2,879.40	$20,456.79
Park St. Tunnel:				
Labor	1,092.10	.....	$2,627.49	$3,719.59
Plant rental	120.17	.....	332.17	452.34
Material	351.32	.....	555.82	907.14
Total	$1,563.59	.....	$3,515.48	$5,079.07
Valve Chamber:				
Labor	421.79	742.63	3,946.84	5,111.26
Plant rental	51.52	45.35	220.30	317.17
Material	165.88	55.03	2,057.69	2,278.60
Total	$639.19	$843.01	$6,224.83	$7,707.03
Grand totals:				
Labor	$30,006.40	$4,227.92	$27,002.32	$61,236.64
Plant rental	4,331.44	770.30	3,366.18	8,467.92
Materials	18,215	316.17	15,123.47	33,655.00
	$52,553.20	$5,314.39	$45,491.97	$103,359.56

Models were then constructed. A model to scale of the Erie St. shaft and adjacent Harbor Entrance tunnel was the largest, about 10 ft. long. It represented the structure divided at construction joints, with details of forms, timbering and all structural parts to scale, and could be opened up to show all interior parts. It was so supported that the shaft could be dropped vertically to indicate the settlement of the Erie St. shaft and its action on the tunnel structure. A separate larger scale model represented the excavation methods and timbering. Even the excavating action of a clamshell working inside a caisson was represented by a model. Supporting these models were photographs of the failure and construction plant and operations.

With the history and models, the city's attorney was instructed in the technicalities of the case, including probable controverting evidence, until he had the facts at his command. At the trial the model was exhibited and used by the attorney and his witnesses to present the evidence to the jury. With the models in evidence no attempt to confuse the facts before the jury could be successful. Its members could visualize the facts and follow the technical evidence with unusual understanding. Indeed it is frankly asserted by those conducting the trial, that the models virtually won the suit for the commission.

Engineers and Contractors—The work described was performed for the Milwaukee Sewerage Commission, T. Chalkley Hatton, chief engineer, James L. Ferebee, principal assistant engineer, and George R. Young, division engineer. The contractor for the original construction was the Western Foundation Co., St. Paul, Minn., and the contractor for the recovery and completion was the John F. Casey Co., Pittsburgh, Pa.

Large Bowl Planned for California Athletes

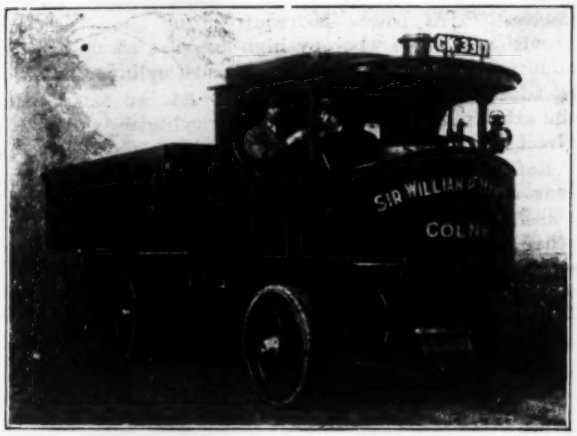
The University of California board of regents has given approval to the plan of the student body and alumni for organizing a campaign to finance the building of a stadium that will cost between $800,000 and $1,000,000. The plan for raising funds with which to construct the large bowl contemplates taking popular subscriptions of $50, in return for which the subscriber will receive a 5-year season ticket.

Why Steam Trucks Are Popular in Great Britain

Influence of Legislation on Vehicle Types—Running Costs—Types Employed Include Both Tractor and Load-Carrying Truck of 5 or 6-Ton Capacity

By George W. Watson
President-Elect, Institution of Automobile Engineers
and H. Scott Hall
Member, Institution of Automobile Engineers

THE design of British mechanically propelled road vehicles is largely governed by the somewhat intricate laws relating to their use on the highway. These legal restrictions are likely to undergo considerable modification in the immediate future and we will not, therefore, waste any time discussing them here. It is necessary, however, to indicate the extent to which they have affected design. They are responsible, for example, for the wide gap between the road locomotive or traction engine, weighing 12 to 14 [long] tons and which has its prototype in the United States, and the steam tractor and motor wagon, which must not exceed a weight of 5 tons unladen, i.e., without fuel or water. It will be the latter class of vehicle—those



UNDER-TYPE OF STEAM TIPPING WAGON

which, in England, come under what are called the heavy motor car acts—with which we are concerned in this article.

The steam wagon is popular in the British Islands to an extent unrealized and unequaled elsewhere. This is due to a variety of causes but probably, in the first instance, to the fact that mechanical transport has been used in these islands for upward of 60 years, during most of which time it was entirely carried out by steam road locomotives. These were, and still are, very popular with showmen who travel from town to town with fairs, circuses and the like. Their engines weighed upward of 12 tons each. Their use and the spread of mechanical transport in Great Britain may be traced through the laws which have been enacted concerning them.

The principal acts were passed in 1861 and 1878, and these heavy locomotives were run under the latter act, which is still in force, one of the provisions being that they should not travel at more than 4 miles an hour, and that they should be preceded by a man on foot with a red flag. When the present type of motor car began to be introduced into, or manufactured in, the British Islands they too were governed by this act and we then had the extraordinary situation that a motor car capable of traveling 20 to 25 miles an hour was not supposed to pass along the road unless preceded by a man walking and waving a red flag. It was to remedy this state of affairs that another act was passed in 1896. This last-named act provided for a new class, a road locomotive which must be under 3 tons in weight, and for vehicles within this limit the absurd restrictions as to speed, etc., were withdrawn. This limitation of weight was subsequently increased to 5 tons unladen, and it was in conformity with that act that the steam tractor began to be made.

Simultaneously makers of steam tractors, seeing the headway which was being made by motor cars, turned their attention to the production of light goods-carrying vehicles which would also comply with the acts. The result was that when the first important trial of commercial motor vehicles was held in 1898 out of eleven machines which took part, only two were gasoline lorries, the remainder being steam wagons. It will thus be seen that the steamer had a start in this country such as it never received elsewhere. It has never relinquished its position, and at the present moment is actually improving it by comparison with the gasoline machine.

Early Vehicles Maintained by Steam Engineers

Another factor which helped the steam wagon was this: The first users of heavy motor vehicles were largely mill owners in the northern industrial districts. They had to have machines which were particularly robust in order not only that they should be able to carry the heavy loads offered but also that they might successfully negotiate the rough roads which were at that time and still are to a certain extent characteristic of Lancashire and Yorkshire, the two main counties concerned. The gasoline motor lorry at that time was anything but robust. Again the steam wagon got a good start.

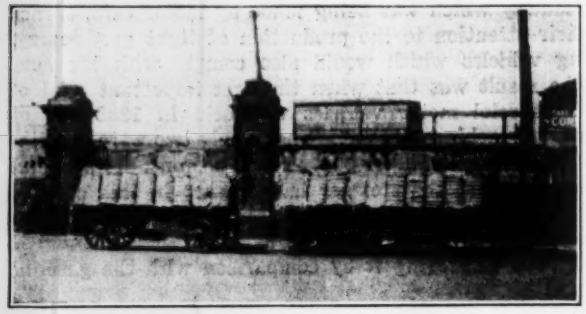
The mill owners had in their employment engineers accustomed to the steam engine, men who understood how to keep boilers in order and how to keep a steam engine in good running repair. They naturally chose for their transport machines which they could handle and repair in their own establishments and by the aid of their own staffs. It was this combination of circumstances which placed the steam wagon in a good position when heavy motor vehicles commenced to be used to any extent in Great Britain. They have never receded; at the present day it is an acknowledged fact that the steam wagon will stand much more rough usage than its competitor and it is invariably the favorite choice when heavy loads have to be moved. Apart from that, it is pre-eminently the vehicle for drawing a trailer, for only in the steam wagon is there that reserve of power and strength which is necessary for the haulage of a trailer up hill and down dale in all weathers.

Finally, and as if to clinch the argument where any doubt arises as to the advantages of this form of transport, the cost of running a steam wagon is less than that of a gasoline vehicle. The following tables are taken from a recent article contributed by one of the present authors to *The Commercial Motor*, the leading British journal dealing with heavy motor vehicles. The table shows side by side the running costs of steam wagons and of gasoline vehicles.

TOTAL WORKING COST (PENCE PER MILE) OF 3-TON AND 5-TON STEAM AND GASOLINE WAGONS, CALCULATED FOR VARIOUS WEEKLY MILEAGES

Miles per Week	3-Ton Steam	3-Ton Gasoline	5-Ton Steam	5-Ton Gasoline
200	19.71	20.12	22.57	25.22
300	16.35	17.68	19.15	22.57
400	14.67	16.46	17.44	21.24
500	13.66	15.73	16.41	20.45
600	12.95	15.24	15.73	19.92

The fact that steam wagons consume coal or coke, the national fuels in Great Britain, has also contributed



STEAM LORRY AND TRAILER AT THE MERSEY FERRY, LIVERPOOL

largely to their extended use. Generally speaking, also, a steam vehicle will give ample warning of the need for repairs, as it may be kept working, without entailing any risk of accident or sudden breakdown, long after the first signs of trouble have become apparent. This is in strong contrast to the sudden troubles which often overtake gasoline trucks. When faults do occur with the steam wagons their cause is at once obvious and their repair simple and quickly effected.

Types Employed

British steam-propelled machines are divided into two distinct classes: One a tractor pure and simple which carries no load and is used for hauling a trailer; the other a wagon which actually carries a load and may also draw a trailer. The former type of machine is of great value to contractors engaged on building construction or civil engineering work where much of the transport consists in moving loads over comparatively short distances between two terminal points. For such work three or more trailers are employed, one of these being loaded while a second one is being unloaded and the third is in transit. These steam tractors are made by about half a dozen manufacturers, and, except as regards minor detail, they are all alike.

In general design they resemble the traction engine or road locomotive, their dimensions and power being such as to enable them to be constructed within the legal weight limit. They are designed to haul a trailer which may weigh about 30 cwt., and carry a net useful load of 5 or 6 tons. The boiler is invariably of the well-known locomotive type. The working steam pressure is usually 200 lb. per square inch and the heating surface varies from 60 to 70 sq.ft., of which from 14 to 18 sq.ft. are in the firebox. The engine is mounted on a saddle-plate on the top of the boiler, the cylinders being toward the smoke box end, and the crankshaft is disposed transversely. The power developed at normal running speed is usually about 20 hp. at a speed of about 300 r.p.m. Compound steam engines are used, as a rule, having high-pressure cylinders 4¼ to 4¾ in. in diameter and low-pressure cylinders of from 6½ to 7 in., with a stroke of 7 to 8 in.

Transmission is by a double train of gears to a large spur wheel bolted to a differential case on what is known as a traction-engine type of live rear axle. Provision is made, as a rule, for two changes of gear ratio, the change being effected by sliding one pair of wheels out of engagement, subsequently sliding another pair into mesh. These gears are generally placed in full view of the driver, and in order to effect a change he must stop the wagon. Where, in exceptional circumstances, extra power is required for short periods provision is made whereby high-pressure steam can be admitted direct into the low-pressure cylinder as well as to the high-pressure cylinder. At the same time the exhaust from the high-pressure cylinder is diverted direct to the atmosphere, up the funnel.

Reference has been made to the traction-engine type rear axle. In this a solid, one-piece axle runs from wheel to wheel, one wheel being keyed thereon. The other road wheel is keyed on a sleeve which is mounted on this axle and is free to rotate thereon. The sun wheels of the differential gear are secured, one to the solid axle the other to the sleeve.

General Dimensions of Tractors

These tractors are of short wheelbase, generally about 8 ft., and the track of the front wheels is narrow, usually in the neighborhood of 4 to 4 ft. 6 in., while that of the rear wheels is from 5 to 6 ft. The front axle is centrally pivoted on a bracket beneath the boiler, and is sprung by means of a single transverse spring. The front wheels, in order to allow a good lock to this type of axle, are necessarily small in diameter, varying from 2 ft. 9 in. to 3 ft. 6 in. by 5 in. wide.

The steering is generally effected by means of a chain which, at its ends, is secured to the front axle, one end of the chain near each wheel. The chain is wound on a transverse drum which is rotated by the steering wheel through the medium of a worm and wheel gear. Generally the connection between chain and axle is made flexible by the interposition of extensible springs. The rear wheels are generally about 5 ft. in diameter and 12 in. wide.

As a rule the front wheels are tired with plain steel bands, and the rear ones by alternating diagonal strakes of steel and wood. During the past few years, however, both manufacturers and users have begun to realize the advantages of rubber tires for this class of work, and solid band tires of a size approximating to that given for the steel wheels are gradually coming into favor.

There is, of course, much bigger scope for use of the load-carrying steam wagon, as distinct from the tractor. This is made in capacities varying from 3

to 6 tons, and in one or two exceptional cases, such as for dock use in Liverpool, where the authorities permit the use of a heavier wagon than is legal on the highway, for 8 tons. The steam wagon of this type is also largely used for hauling a trailer carrying 3 to 4 tons, as well as carrying its own superimposed load. Steam wagons compete on level terms with gasoline trucks. Where there is much to be gained by hauling a trailer the steam wagon has distinctly the advantage.

Owing to the greater scope for its use much more thought and ingenuity have been spent on the design of the steam wagon than on that of the tractor, and the result is that although broadly there are only two main types, with a strong line of demarcation between them, there are also one or two manufacturers whose machines exhibit unusual features. The two types are known as the "over-type" and "under-type," the designation implying the position of the engine, which on the one is, as described in connection with steam tractors, above the boiler, and in the other is below the chassis. Whichever type is made there is generally very little to distinguish to the outward eye between the various models and capacities made by different makers, except in the case of special machines, such as the 8-tonners. Generally both boiler capacity and engine size are standardized for loads of from 3 to 6 tons, the difference being in the strength of the frame and size of the wheels, together with alterations in gear ratio.

The "Over-Type" and The "Under-Type"

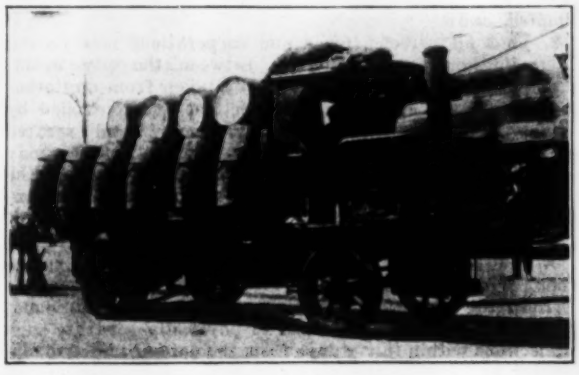
The "over-type" is constructed on very much the same lines as the tractor, already described. Let the reader imagine that the boiler, engine, and essential components of the tractor are made particularly compact, but that the frame, which is usually of rolled steel channel, although of late pressed steel has come into favor, is extended rearward until it is of a length sufficient to accommodate the usual bodywork. The final gear transmission of the tractor is replaced in the wagon by a long single roller chain. The boiler capacity differs very little from that of the tractor. The pressure, however, is a little higher, being usually 220 to 230 lb. per square inch. The engine is generally of the compound type, with cylinders 4 and 7 in. in diameter, and 7 in. stroke.

The transmission gear is similar to that of a tractor, with the exception of the final chain drive, and the arrangement for effecting the change of gear is also the same. The steering gear is similar, but the wheel diameters are naturally not quite the same. The front wheels are generally about 2 ft. 9 in. and the rear wheels 3 ft. 4 in. in diameter. The track of the front wheels is from 3 ft. 6 in. to 4 ft. and that of the rear wheels from 5 ft. 9 in. to 6 ft. 6 in. The wheel base varies from 12 to 14 ft., according to requirements.

At one time it was the general practice to fit wagons with steel tires only, but rubber tires began to be fitted about 1911 to 1912, first to 3-tonners, then to larger sizes, until at the present time there are few steam wagons being made which are not fitted with solid rubber tires. We have not yet, however, reached the stage when anyone has seriously considered the fitting of giant pneumatics to this type of vehicle.

The under-type steam wagon is as different from the other as is possible. In this type the vertical type of boiler is preferred; it has a cylindrical firebox within a cylindrical boiler shell, the firebox being crossed by a number of nearly horizontal water tubes, which traverse the fire space. The heating surface of these boilers is generally a little less than the loco type, but they are remarkably efficient. The working pressure varies from 200 to 250 lb. The boiler is fitted at the extreme forward end of the wagon; the driver sits immediately behind it and stokes either through a hole in the top of the boiler, down a vertical chute, or through a hole in the floor of his cabin, down a diagonal chute, to the grate.

The engine is located below the chassis, being hung from the side members, and is disposed just behind the driver's cab. It is horizontal and of the twin high-



LOADED STEAM LORRY, LIVERPOOL

pressure type, not compound. Its running speed is about 200 r.p.m. and has cylinder dimensions of 6¾-in. bore and 10-in. stroke. There is no change-speed gear, the drive being transmitted from a sprocket pinion on the end of the crankshaft by roller chain to a sprocket wheel on the differential gear of the rear axle, which is usually of the traction-engine type. In this type of steam wagon the steering gear is generally similar to that of the motor car, and is known in Great Britain as the Ackermann type. This type of wagon is growing in favor, though this is largely because of the fact that owing to the boiler not occupying so much space longitudinally there is more space behind the driver's cab, and more weight can be imposed upon the front axle, thus keeping the rear axle weight, when the wagon is fully loaded, within the legal limits of 6 tons for a wagon which may travel at 12 miles per hour, or 8 tons for a wagon which may travel 8 miles per hour.

Superheated steam is not greatly favored for over-type steam wagons, and on these engines the plain D-shape slide valves or piston valves are adopted, and wherever superheat of appreciable degree has been employed a certain amount of trouble has resulted in connection with the lubrication of these valves. With the under-type, however, superheated steam is invariably used, and in the engines of these machines poppet or ball valves are generally incorporated. As has been indicated in the foregoing, these wagons are built in all sizes from a minimum of 3 tons upward. The most popular type, however, is undoubtedly the 5-tonner in the case of the over-type, or the 6-tonner in regard to the under-type, the difference in capacity of the two types being largely due to what has been pointed out in respect of the legal limits and the capacity of the under-type for taking a bigger load without exceeding the limit of rear axle weight.

Abolition of Double Check Valves on Hartford Water-Works

ACTING on a report and recommendations by its manager and chief engineer, Caleb M. Saville, the Board of Water Commissioners of Hartford, Conn., voted late in 1920 to require the abolition of all connections between the public water-supply of that city and other sources of supply, including those protected by double check valves. The resolution of the Board is given in full, as of possible use elsewhere:

1. That the report of the manager and chief engineer on "Use of Double Check Valves," dated Oct. 18, 1920, be accepted and that the recommendations therein be adopted, and

2. That all persons, firms and corporations now having or maintaining any connection between the city water-supply and a source of water supply taken from any other source, whether or not such connections are controlled by automatic devices such as check valves or by hand operated mechanisms such as gate valves or stop cocks which may or may not be sealed, be notified by the secretary of the board to discontinue and physically separate all such connections forthwith and that hereafter all connections of similar character are prohibited and enjoined, and

3. That failure on the part of persons, firms and corporations to discontinue the use of any and all connections between the city water supply system and any source not supplied from such system and to physically separate such connections within thirty days from the date of notice to disconnect or to make any such connections hereafter will be sufficient cause for the Board of Water Commissioners on notification from the manager to order discontinuance of city water service to the premises on which the connection exists, until such separation is accomplished, except

4. That in the case of persons, firms and corporations now having connections governed by the double check valve mechanism of the so-called Factory Mutual type, the time of discontinuance of the same be extended until Sept. 1, 1921, provided these valves are subjected to such inspection as the board deems proper, the expense of which will be borne by the person, firm or corporation now having such connections, and

5. That the manager be and hereby is directed to carry out the provisions of this vote.

Engineer's Report

Mr. Saville's report is given below nearly in full, with the omission of his final recommendation, which was substantially the same as the resolution of the Board:

As a matter of strict sanitary regulation of a water supply used for domestic purposes every reasonable precaution should be taken to exclude all known sources of pollution. This may be accomplished by elimination, by filtration, by sterilization, and to some extent by storage. In the opinion of sanitary engineers and practical water-supply operators, connections controlled either by automatic devices, as check valves, or by hand operated mechanism, as gate valves, which may or may not be sealed, are not included in any of the approved methods at present in vogue for the protection of a safe and clean water supply against contamination from one which is polluted and dirty.

It is well recognized by all fire insurance interests that proper fire protection to important factory or industrial works requires a secondary supply of water from a source independent of the primary supply. To accomplish this purpose, however, there are safe and approved methods which may be substituted for connections with a polluted source. Such methods of secondary supply, as from tanks and cisterns, are authorized and satisfactory to the majority of engineers versed in fire protection engineering.

The matter of danger of dual connections was brought to the attention of the board Sept. 20, 1919, because of indication of serious pollution in the city water supply in the center of the city. The source of this pollution was traced to a connection in a store building where the city system was interconnected with a supply from driven wells. At that time the board passed a vote discontinuing and prohibiting the use of auxiliary connections but later stayed its execution to obtain further information relating to fire protection supplies.

It is perhaps necessary to state that many serious epidemics of typhoid fever elsewhere have been traced without question to dual connections existing between city water-supply systems and an auxiliary source of supply which was more or less protected by automatic or hand-operated devices. These are matters of record and to cavil at details is merely to dodge the issue.

Danger to Health

In every case where the matter of connections between a city water supply and a polluted source have been considered, including those protected by the so-called "F. M." system of double checks, danger to health of consumers has been recognized. In some places on account of this fact all such connections are prohibited, as in Stamford, Conn., Providence, R. I., Springfield and Lowell, Mass., St. Paul, Minn., Cleveland, Ohio, Terre Haute, Ind., and others. The Minnesota State Board of Health absolutely prohibits such connections and has ordered out existing ones. The State Board of Health of Illinois "sanctions no such physical union in the installation of new factory fire supplies."

From a water-supply standpoint a principle is involved which is of practical application and not theoretical discussion. From the very nature of the case no argument can be successfully defended that there is no danger to health through these connections. On the other hand, from a fire protection standpoint, other approved means are at hand to accomplish the result.

No automatic device can be relied upon for absolutely perfect working at all times and even if tight there is no assurance that at any time unknown to factory officials an ignorant or careless workman may not make connection inside the building which will serve to bypass the polluted water around the check valve and into the city system.

The expert called by the manufacturers particularly spoke of the danger of pipe moss getting under the clapper of the valve and keeping it open. Similar danger exists from wads of joint packing and sometimes even pieces of wood. No flap valve, no matter how perfectly constructed, can be made proof against such conditions.

Experience in Hartford

The courts have recognized the responsibility of water-supply companies both public and private to take every known means to protect the health of consumers from water-borne diseases. In Hartford, since the installation of these valves in 1919, there have been 61 instances of leakage through one of the two check valves on these connections, and on six occasions both valves were found leaking at the same time, although in all cases the valves were left tight on previous inspection. Water systems elsewhere report similar experiences of leakage except that of both valves leaking at the same time and this may be due to less thorough methods of inspection.

When installed, the present check valves were sponsored by the Manufacturers Mutual Fire Insurance Co. as a substitute for complete separation, yet after a comparatively short time the design was changed to remedy defective action. At the present time even this design is roundly scored and condemned by the expert sanitary engineer representing those who would retain the dual connections.

As to the relative danger to health with their retention and that alleged from fire with their discontinuance, there seems little necessity for debate.

The question here, however, is not what degree of safety to health can be had with proper fire protection because fire protection adequate in the opinion of all fire insurance engineers except those of the Factories Mutual

can be had by other methods which require no connection between the city water supply and a polluted source.

In spite of all the arguments which are brought forward in favor of the retention of these connections, the condition of accountability of those in charge of the city water-supply stands out strong and clear. Remote as may be the chance of pollution through these connections, on one, not even the sanitary expert speaking in favor of them, has been willing to deny that a chance of pollution does exist. If pollution of the public water-supply should obtain and an epidemic of typhoid fever ensue, the responsibility for death, disease and impairment of health must rest squarely on the shoulders of those officials who are in charge.

By vote of the people, it was decided some years ago to seek a water supply at a distance rather than filter the water of the Connecticut River. This choice entailed much greater expense than if the river water had been taken, although the latter could have been made unquestionably safe. In other words, the people of Hartford wanted not only a safe water but one which would be above suspicion.

The present auxiliary connections join together city pipes which in a short time will be carrying carefully filtered water with pipes into which may be forced water flowing in the Park River which is dirty and foul with sewage and waste. Under certain combinations of circumstances this water may be injected into the pipes carrying water for the domestic use of the citizens.

Cost Keeping on Asphalt Paving

By Henry C. Browne
Division Engineer, Lane Construction Corporation, Meriden, Conn.

Extract from "Suggestions for Asphalt Paving Contractors" to be published by the Asphalt Association, New York, N. Y.

PLANNING and co-ordination of work are of extreme importance in highway construction. When the methods to be used have been determined, a progress plan of the work should be made. The need of plant and materials necessary for the work should be anticipated far enough in advance so that no delays will occur for lack of them. A well-defined plan of progress will enable the contractor to keep the work more closely co-ordinated.

A daily report of progress may be made on a form similar to the one shown. The report should show each day the total of the work performed to date. By comparing these reports with the progress anticipated, the work can be speeded up where necessary, or the original plan modified to suit the conditions which prevail. Another valuable feature of this report is the listing by car number of the material imported by rail. Material which is slow in arriving can be traced and rushed and one only has to look at the last report to learn the whole situation. Careful planning will prevent having too many laborers who cannot work to advantage because some other part of the work is held up for a cause that could have easily been foreseen.

Contract Headings	Headings for Cost Classification
28,500 sq.yd. grading	Grading
28,500 sq.yd. 2-in. Topeka	2-in. Topeka Plant repair Asphalt Filler Sand Stone Mix Haul mix Roll mix Lay mix Coal and oil
1,375 cu.yd. sand filler	Sand filler
5,652 tons trap rock	Trap rock Stone at car Load Haul Spread Roll Coal and oil

Many of the items of work on a highway contract are difficult of exact measurement until the final survey is made. The daily expense on the job should be kept and classified into at least as many subdivisions as there are items in the contract and sometimes it is advisable to make further subdivision. To illustrate, the foregoing list is given which shows on the left side the contract quantities and on the right side the subdivisions that might be made in classifying the costs.

DAILY REPORT

THE LANE CONSTRUCTION CORPORATION,

MERIDEN, CONN.

Name of Contract ..... Date .....

Work entirely stopped ..... hours. Due to .....

Road bed grade completed.
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Lost time ..... hrs. due to .....

Sub base completed.
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Lost time ..... hrs. due to .....

Concrete base completed.
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Lost time ..... hrs. due to .....

Surface completed.
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Lost time ..... hrs. due to .....

Shoulders completed.
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Sta. ..... to Sta. .....
Lost time ..... hrs. due to .....

Local Stone, Total to date on Road ..... Tons
Car Stone, Total to date on Road ..... Tons
Car Sand, Total to date on Road ..... Tons

Concrete Culverts.
Yardage required ..... Yardage laid .....

Total Cement received ..... bags. Cement Used ..... bags.

Bituminous Material Received { ..... gals. / ..... tons. } Used { ..... gals. / ..... tons. }

Corrugated Pipe	Vitrified Pipe	Iron Pipe
Received ..... Feet.	Received ..... Feet.	Received ..... Feet.
Laid ..... Feet.	Laid ..... Feet.	Laid ..... Feet.

	Cars				Cars		
	On Track	In Transit	On Demurrage		On Track	In Transit	On Demurrage
CEMENT				SAND			
STONE				BITUMEN			

*Give Car Numbers.

In urgent need of following material which has been ordered but not received.

Signed ..... Approved ..... Supt.

DAILY REPORT FORM FOR ASPHALT ROAD CONSTRUCTIONS

A superintendent can roughly estimate the daily output on the different parts of the work and from his classified expense arrive at the unit costs of the work. The frequency with which the daily classified costs should be sent to the office is optional with the contractor. While some prefer to know the total expended each day, others do not require the classification costs to be submitted except with the payroll which may be once a week or once in two weeks. A superintendent should approximate his unit costs from day to day. The need for checking up the cost of work oftener than every one or two weeks is not so essential in the case of superintendents in whose ability the contractor has the utmost confidence, as it is in the case of superintendents whose knowledge of work is not so proficient. An analysis of costs will sometimes show where expensive but avoidable mistakes are being made.

If a contractor has certain rules or methods which he wishes followed in conjunction with the work, it is advisable that he prepare a set of instructions covering them and put it in the hands of each superintendent. Much confusion will be avoided by doing this and there should be no excuse on the part of the superintendent for his failure to comply with the written instructions. Written reports of superintendents, if made on printed report forms furnished by the office, will facilitate the recording work of the office.

Tunnel Concrete Lining Placed by Pneumatic Gun

Nearly Two Miles of 10-Ft. Pressure Tunnel at Caribou Hydro-Electric Plant in California Placed by Novel Machine

By W. D. Shannon
General Superintendent, Stone & Webster, Inc., Belden, Cal.

THE success of placing concrete lining in tunnels by the pneumatic method has recently been well demonstrated on the tunnels of the Caribou hydro-electric development for the Great Western Power Co. of California. Tunnel No. 2 of this project is 9,213 ft. long, and 10 ft. finished diameter, and the concrete arch lining for the entire length was placed pneumatically. This tunnel is a part of the hydraulic system of the Caribou plant, and is used to convey the water from Butt Creek to the head of the penstocks.

Fig. 1 is a profile of this tunnel showing the two adits and upraise, from which all the work of concreting was carried on. That portion of the tunnel between the intake and adit No. 1 was handled from a concrete plant located at the upraise, the plant being on the ground surface and the concrete sent by gravity to cars in the tunnel. A 12-in. wrought iron pipe was used to convey the concrete from the mixer to the tunnel. From the bottom of the upraise the concrete was distributed to the heading in trains of three cars each, and delivered to the concrete guns; one machine working from adit No. 1, and a second machine working from the intake, each traveling toward the upraise. In the first operations only one crew was used, working the concrete guns alternately, while the form builders worked in the opposite heading. This plan was carried out during the placing of the arch between the intake and adit No. 1, and an average of 70 ft. per day was maintained.

That portion of the tunnel between adit No. 1 and adit No. 2 was handled somewhat differently. The two concrete guns were started at approximately the midway point between the two adits, and worked toward their respective adit. A plan was therefore worked out to build forms while placing the concrete. By this method a maximum of 156 lin.ft. of arch was placed in 24 hours, and an average of 105 lin.ft. per 24 hours was maintained over a period of 25 days. The invert thickness is 12 in. and that of the arch 9 in. Only the arch was placed by the gun.

The concrete gun or "pneumatic concrete ram," as it is called by its makers, is shown in the drawing in Fig. 3 and the view in Fig. 5. It differs from other machines used for the same purpose in that the concrete charge is started through the delivery pipe by means of a piston. This "gun" requires that the mixed concrete be delivered to it and deposited in the concrete chamber, the air pressure being used for delivery only on the last 200 ft. of the distance from the mixer to the heading. The machine is mounted on trucks and as shown moved along the invert as the lining progresses. It has a capacity of 18 cu.ft. and works under normal air pressure of 90 to 100 lb. per square inch. The main diameter is 36 in. The device is patented and manufactured by Webb & Coxe of Los Angeles.

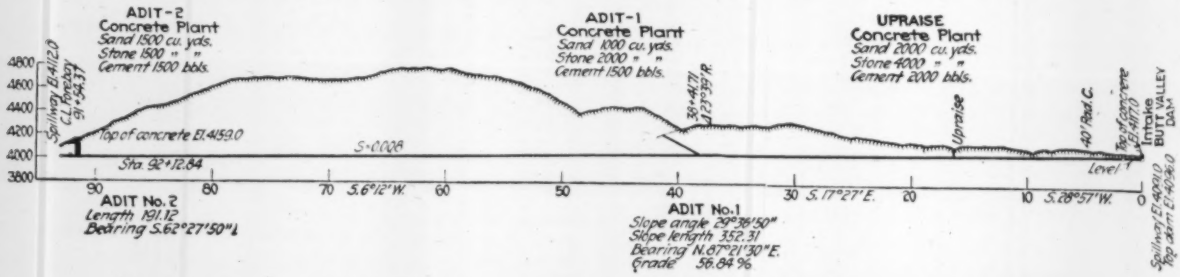


FIG. 1. PROFILE TUNNEL NO. 2. CARIBOU HYDRO-ELECTRIC DEVELOPMENT IN CALIFORNIA

Fig. 2 shows the concrete gun in place, the direction of travel being toward the right. The gun was moved forward on the invert the required distance, and the air connections made, after which the overhead track was lowered and the discharge pipe hung to the roof of the tunnel timbers The arch forms were then constructed, the key forms at the top of the arch being omitted, to be put in place in 5-ft. sections as the concrete discharge pipe was removed.

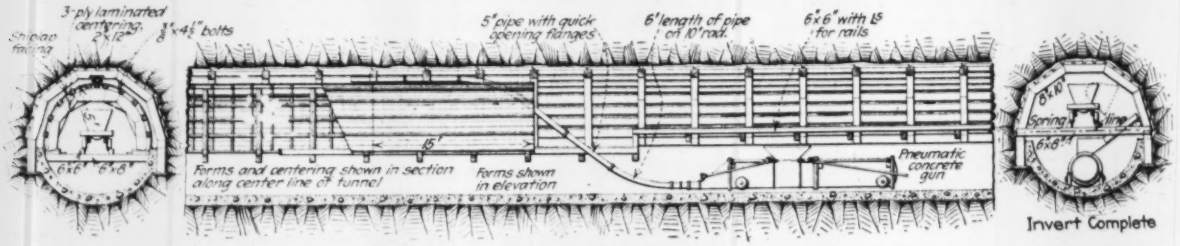

3-ply laminated centering
5" pipe with quick opening flanges
6' length of pipe on 10' rad.
6"x6" with L5 for rails
Forms and centering shown in section along center line of tunnel
Forms shown in elevation
Pneumatic concrete gun
Spring Line
Invert Complete

FIG. 2. SHOWING METHOD OF PNEUMATIC CONCRETING OF CARIBOU TUNNEL

Cars of 24-in. gage and 20 cu.ft. capacity were used to handle the concrete from the plant to the concrete gun. The entire load was dumped into the barrel of the gun and "shot" in one charge with an air pressure at the nozzle of 100 lb. Smaller air pressures were sufficient to force the charge into the delivery pipe, but the best results were obtained with the above pressure. About one minute was required to "shoot" a batch of concrete under the above conditions. An important feature of the air supply was a receiver of not less

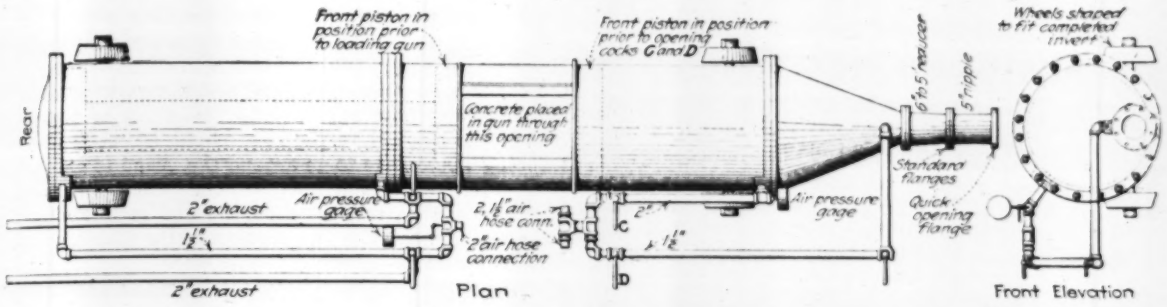


FIG. 3. DETAILS OF CONCRETE PNEUMATIC GUN USED ON CARIBOU TUNNEL LINING

than 200 cu.ft. capacity, located as close to the nozzle as possible, but with a 3½-in. air line it was found satisfactory to have the receiver at the adit mouth, and maintain 105 lb. of pressure. The quantity of air used depended largely on the length of concrete discharge pipe and the condition of the concrete. A dry mix was found to require nearly twice as much air as a wet mix, but a compressor handling 500 cu.ft. of free air per minute will supply the gun under average conditions.

Another very important feature was the long bends in the 5-in. concrete discharge line used in lifting the concrete from the gun to the arch, and in carrying the concrete over horizontal angles. It was found after experiment, that pipe bent on a 10-ft. radius gave the best results with the least wear to the metal. Good sharp river sand was used in mixing the concrete, but experiment showed that river gravel passing a 1½-in. screen, or slightly smaller, gave good results with minimum wear of the pipe. Crushed rock of the same size could be "shot" as easily as the river gravel, but the pipe bends would cut out in a few hours.

Replacement of worn out pipe sections and the removal of end sections as concreting progressed, was made easy by special flanged connections shown in Fig. 3. These flanges were screwed to the sections before going to the tunnel. To take down a joint simply required the loosening of two bolts which swung out of place when the nut was slightly turned. A round rubber gasket specially designed to stay in place made the joint air-tight. The pipe sections were cut into 5-ft. lengths. This length was easily handled, and enabled the workmen to keep the discharge end of the pipe within a short distance of the placed concrete. Best

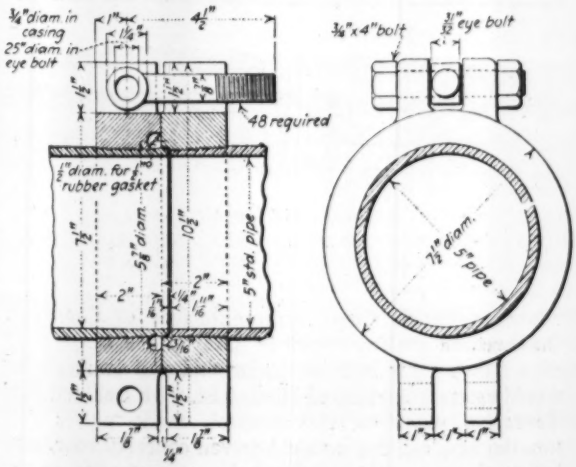
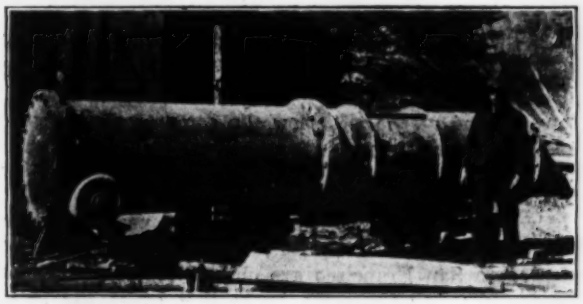


FIG. 4. DETAIL OF FLANGE JOINT IN CONCRETING PIPE

results were obtained when the pipe was kept not more than 7-ft. distant from the concrete.

An improvement in the gun itself over what was originally provided was the substitution of cast-iron piston rings in the piston driving the concrete into the nozzle. The hydraulic packing used at first required daily replacing, while the cast-iron rings with daily cleaning and oiling lasted several weeks.



PNEUMATIC CONCRETE GUN OUTSIDE THE TUNNEL

At no time during the concreting of the arch was the gun placed more than 200 ft. away from the forms, as it was found by experiment that the pipe plugged too easily if shooting was done at a greater distance. This plugging was reduced to a minimum only after experienced operators who could handle the gun were found. An operator could tell by the air gages, and by the sound of the concrete traveling in the pipe the exact condition of the charge, and could regulate his piston travel and air accordingly. As the work progressed in the various headings, the operators became more experienced and fewer plugs in the discharge line occurred.

The work of lining the arch of the tunnel was begun Nov. 15, 1920, and completed March 25, 1921. The entire Caribou development, including the tunnel, was constructed by Stone & Webster, Inc., of which S. L. Shuffleton is western manager, and the writer general superintendent.

Prize Offered for Hardness-Testing Device

A prize has been offered by Sir Robert Hadfield, under the auspices of the Institution of Civil Engineers (Great Britain), for the best design of apparatus for measuring the hardness of materials, especially under such conditions and in such locations as are not suitable for the use of present devices. A fund of about £150 is available. Communications, accompanied by drawings or models, should be submitted to the Institution before Dec. 1, 1921.

San Francisco Bay Bridge Project Revived by New Plans

Schemes for Tying City by Bridge or Tunnel to Mainland—One Comprehensive Study for Years to Come

THE plan of bridging or tunneling San Francisco Bay to do away with the ferry between the city and the east shore is again up for consideration. Last fall three independent bridge or tunnel projects, all apparently based on more or less engineering study, were brought forward within a few weeks. As a result of the interest thus aroused, cities on both sides of the bay appointed committees to consider the matter and compile data relating to trans-bay traffic, conditions of the bay bottom, and costs of bridge and tunnel construction. More recently, as stated in the news pages of *Engineering News-Record*, June 16, 1921, page 1053, a private enterprise has announced that funds were available for the construction of a trans-bay bridge according to plans prepared by Gustav Lindenthal of New York. A campaign is now being carried on by the motor truck dealers' association of San Francisco, which is using a series of full page advertisements in the daily newspapers and otherwise endeavoring to build up a popular realization of the need for better access to the city. In view of these various activities space is devoted to a résumé of the situation and some of the suggestions already made.

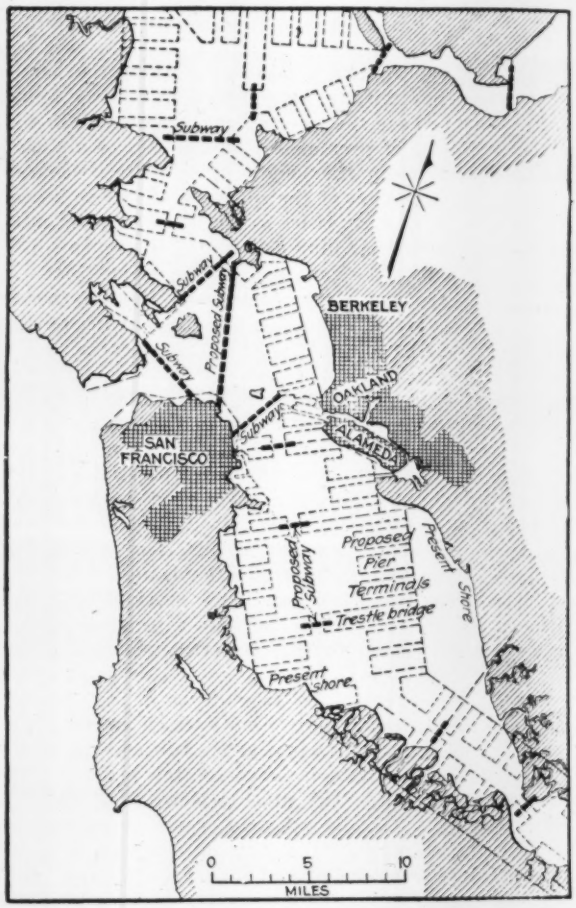
Ferry Service Inadequate

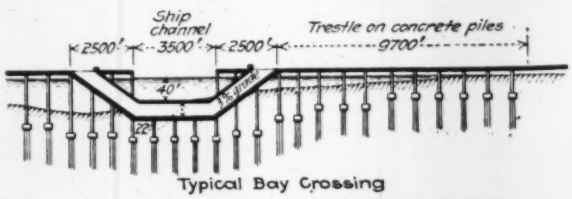
Except for the trains that come up the peninsula over the Southern Pacific coast line, all steam line passengers coming to San Francisco are obliged to cross the bay by ferry, using the same boats that carry the local traffic. The ferry service is inadequate both on automobile and passenger lines. In the evening rush hour the ferries are so over-crowded that the boats go out with passengers standing tightly packed on the outside of both upper and lower decks fore and aft. The automobile boat service is in still worse condition. These boats have to make a 5-mile, 45-minute trip as against the 2¾-mile, 20-minute trip on the passenger ferries because the nearest city street landing on the east shore is well inland. As no more than a limited number of machines (about 100) can be taken on each boat, and despite the fact that present conditions doubtless discourage much trans-bay auto travel, it is not unusual for long lines of machines to wait hours to get across when the ordinary week-end or holiday rush is on.

Admiral Jayne's Plan.—Rear-Admiral Joseph L. Jayne, U. S. N., when commandant of the twelfth naval district last fall, proposed that the present Key Route trestle from the Oakland shore be extended to Yerba Buena Island, which would be converted into a union terminal, and that a ferry and later a tube be provided to connect the island with the foot at Market St. Admiral Jayne is quoted as saying that this plan "has been the subject of correspondence between the district commandant and the Navy Department and, while no decision has been reached in regard to it, I have received the authority of the Secretary of the Navy to take up the question with local interests."

Announcement of the Jayne plan and the tentative approval by the Navy came as a surprise, not only because the island has long been owned by the federal government and used as a naval training station, but also because it has been believed by engineers that the Navy would never look with favor upon the closing of the channel between this island and the east bay shore. Opposition at once appeared in the shape of protests that if the channel to the east of the island is closed, shipping would have to go around the island to get from the western waterfront to the inner harbor—this making it necessary, too, the dredging and maintaining of a channel through the shoals north of the island.

Goethals Plan.—Howe & Peters, consulting engineers of San Francisco, have been working for nearly two years as Pacific Coast representatives of George W. Goethals, in getting together data on the construction of a subway for both vehicular and rail traffic, which would connect the foot of Market St. with Oakland Mole. Tentative plans on this project, made public some months ago, call for a shield-driven concrete tube, similar to the type General Goethals recommended for the





IDEAL DEVELOPMENT OF SAN FRANCISCO HARBOR AND LOCATIONS OF BRIDGE AND SUBWAY CROSSINGS (LITTLE)

New York-New Jersey tube under the Hudson River.

Provision would be made for two decks, the upper for use of motor vehicles and the lower for electric trains. The upper roadway would permit of two traffic streams, one going each way, with ample room in the center for lighter cars to pass trucks and other slow-moving vehicles. Tracks on the lower deck would accommodate all classes of railroad traffic. The gradient would be kept below 3 per cent so freight could be handled easily. The depth of water along the route the tube would follow does not exceed 65 ft. and soundings taken at various points indicate that its entire length would be in blue mud. Not only would mud facilitate driving by the shield method, it is pointed out, but it would constitute a cushion to safeguard the tube from possible disalignment due to earthquake shocks.

The opinions thus far submitted on this plan are only of a very general character and recommendation is made for a thorough preliminary investigation such as would cost about $25,000. If the results of such a survey confirm the rough estimates, it is suggested that the construction of the entire 3.5-mi. concrete tube would be between $40,000,000 and $50,000,000.

Goethals Favors Tunnel

In commenting on this project General Goethals is quoted as saying, "as between a bridge and a tunnel connecting San Francisco and Oakland shores, the tunnel would be the more satisfactory construction, particularly in view of possible and even probable objection by the war department to a bridge. The depths are not excessive and there would be no difficulty other than might be created by the character of the material encountered in construction."

By way of indicating the amount of investment that might be warranted in such a tube, Howe & Peters have tabulated the following traffic data: In 1912 the ferries serving three steam railroads and one electrical line carried across the bay a total of 33,000,000 passengers; in 1918 the Key Route and the Southern Pacific carried a total of 39,165,000; and in 1919 the same lines carried 41,961,000 passengers; in 1919 some 2,253,500 motor vehicles were taken across the bay by ferry. Based on the rate of increase shown up to 1919, it is estimated that by 1940 more than 100,000,000 passengers and between 10,000,000 and 15,000,00 motor vehicles will cross the bay annually.

Little Plan.—A comprehensive study of the future bridge requirements of the entire San Francisco Bay district, made several years ago by John G. Little, begins with the assumption that ultimately there will be dense population distributed more or less uniformly from one end of the bay to the other, with the financial center still about where it is now but with the industrial centers shifted to outlying points. On this basis he prepared maps indicating the location of some eighteen crossings at various points on the bay which would ultimately be required, the idea being to have in mind the ultimate program when the first units are constructed.

Of these several crossings a combined trestle and tube suggested for immediate construction about 1½ miles south of the Ferry Building, Mr. Little says, is "cheaper than any scheme for crossing the bay which has yet been proposed, will meet all of the requirements for safety and convenience, and will eventually add to, rather than detract from the shipping facilities of the harbor." This structure would begin on the San Francisco side at the intersection of Sixteenth and Kentucky Sts. and end on the east shore at the intersection of Lincoln and Adeline Sts. (the latter projected), a distance of 4¾ miles. The water depth along this route nowhere exceeds 60 ft. The construction recommended is a concrete trestle or viaduct at the elevation of the present docks and having a depressed section or tube at the point most desirable for an unobstructed ship channel. The viaduct could, when future growth warranted it, be skirted on each side by piers projecting at right angles to the viaduct.

The office of the Chief of Engineers, U. S. A., is definitely on record as opposed to any low-level bridge north of San Mateo and has expressed the opinion that a tunnel is preferable to any bridge, but at the same time it made the statement that "a modification of the plan presented by John G. Little might prove workable."

In preparing estimates for the San Francisco Chamber of Commerce based on prices as of October, 1920, Mr. Little compiled the following cost estimates.

(1) For a wood trestle built out from each shore leaving a central ship channel of, say, 3,500 ft. clear width, and using ferry boats across this channel, pending the construction of a subway:

25,000 lin.ft. 21-ft. highway on creosoted pile trestle	$1,410,000
2 ferry houses on creosoted piles	90,000
Approaches	100,000
2 ferry boats	1,000,000
Promotion	400,000
Total cost, trestle and ferries	$3,000,000

(2) For a concrete highway supported on concrete piling and planning the immediate construction of a tube in place of the ferry:

25,000 lin.ft. 21-ft. highway (concrete)	$3,250,000
2,000 ft. concrete tube, giving a 40-ft. clear channel	5,000,000
Approaches	750,000
Promotion	1,000,000
Total cost, highway and tube	$9,000,000

In connection with this plan, Mr. Little recommended the construction of a tube under the estuary to the Sixteenth St. station in Oakland and a second tube at the foot of Broadway, Oakland.

A later modification of the Little plan, made by C. H. Snyder of San Francisco, provides for the same general construction but places the ship channel at the San Francisco end, thus building inshore one of the inclines down to the tube and putting the entrance to the shore incline on Fourth St. between Channel and Kentucky Sts. Mr. Snyder proposes the use of pre-cast concrete tube sections 24 ft. long floated to place and sunk onto accurately placed concrete piles. J. Vipond Davies of New York is quoted as having approved this plan.

Other Plans.—Some years ago plans were brought forward for a high-level bridge from the top of Telegraph hill to Yerba Buena Island. Objections to this were the very high cost and the climb necessary to reach the San Francisco end.

A means of relief for the automobile congestion that would be inexpensive and could be speedily completed is the proposed Dumbarton cutoff highway. This would call for the use of the present railroad bridge or a new bascule bridge across the south end of the bay at point Dumbarton. Here government restrictions are not believed to require a clear channel of more than 125 ft. and good concrete boulevards have already been built down both sides of the bay. Plans and estimates have been made on this proposal showing total costs as low as $600,000. The great drawback, however, is that the crossing would be 25 miles south of the Ferry Building.

Railway Relocation to Eliminate Sliding Hillside

Operation Stopped by Shifting and Subsidence of Banks, Trestles and Cuts—Advice for Location on Wet Sidehills

RECONSTRUCTION of a portion of the Alberta & Great Waterways Ry., in Canada, has been made necessary in order to put the line on stable ground and to eliminate a 9-mile stretch which has been wrecked by the movement of a hillside. This movement was started by the excavation for the original roadbed, with the disastrous results shown in Figs. 1 and 2. The northern part of the line was abandoned and is out of operation until the new connection can be completed. This railway was acquired by the government of the province of Alberta in 1920, and the improvement and relocation have been under the direction of H. A. Warner, chief engineer and superintendent. The route is approximately northeast from Edmonton for about 300 miles to Fort McMurray, at the junction of the Clearwater and Athabasca rivers, in north latitude 56 deg. 40 min. This is said to be the most northern point thus far reached by the railway system of North America, with the exception of the isolated lines in Alaska and the Yukon district.

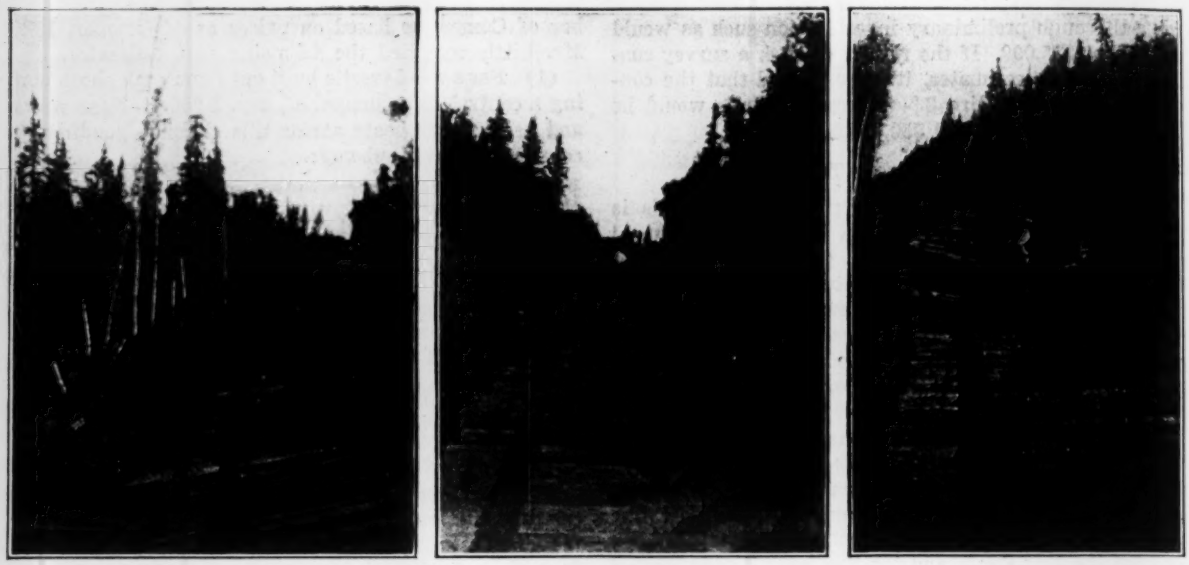


FIG. 1. SLIDING HILLSIDE PUTS NORTHERN CANADIAN RAILWAY OUT OF OPERATION

As built originally the railway approaches Fort McMurray along the south banks of the Clearwater and Athabasca rivers, as shown in Fig. 3, and it is here that the sliding has occurred. The two valleys are about 400 ft. deep, with side slopes averaging 12 deg., and are cut through limestone overlaid with bituminous sands of varying thickness (McMurray tar sands) which show outcrops on the slopes and are exposed occasionally in the railway cuts. Overlying the tar sands and forming the face of the slopes where the sand outcrops do not occur is a much thicker bed of alluvium of glacial origin, containing a large percentage of boulders.

At Mile 274.5 the line begins to descend into the valley of the Christina River and it reaches the flats of the Clearwater River at Mile 283.5. This is the distance affected by the slides, nine miles, with a fall of 460 ft. from El. 1,280 on the plateau to El. 820 on the flats. The grade is 1 per cent compensated for curvature and fitted to the topography with 10 deg. curves, the roadbed being 14 ft. wide on fills and 22 ft. in cuts. The quantities are fairly well balanced, so that the characteristics of the profile are through cuts and medium fills, with a comparatively small amount of trestling. The earthwork per mile averaged 24,200 cu.yd. in cuts and 23,700 cu.yd. in fills. Culverts are of native timber, without floor, paving or riprap protection.

Topographic Conditions

An extensive swamp occupies the plateau forming the summit of the divide between the Clearwater River and Deep Creek, and as the bulk of the water precipitated is unable to penetrate the tar sands it percolates through the subsoil and appears on the Clearwater side as seepage. The sidehill is clothed with a dense forest of spruce, and as it has a northerly aspect it receives but little sunshine in these high latitudes, so that evaporation of the seepage is retarded and the growth of moss is encouraged. This moss, in combination with rotten logs and other forest debris, covers the ground to depths approaching in some places 5 or 6 ft., not only retarding the natural evaporation but also obstructing the surface drainage. When undisturbed, therefore, the soil is held in a constant state of saturation and yields up its moisture slowly, but when it is opened up by a cut, the groundwater of this natural reservoir is tapped and percolates more or less rapidly through the sides of the cut, causing destructive scour and slides.

When the alluvium is saturated it becomes practically viscid and its tendency to slide is increased by the presence of boulders in the moss covering. Although considerable damage had been occasioned by sliding cuts, the fills gave the most trouble, the ground on which they rested being too soft to bear their weight, so that they would either move bodily downhill or subside into the soil, often leaving no trace of their previous existence. Over the worst section of four miles about every fill has been displaced, the characteristic

condition being that from the mouth of every cut the track deflects sharply downhill, while also sagging deeply in the vertical plane. Some fills have cracked longitudinally, the downhill half sliding away from the uphill half. Where fills have disappeared and been replaced by trestles most of the trestles have also suffered both lateral and vertical dislocation, the piles having either subsided and pulled away from the caps or having been pushed down hill by the movement of the ground in which they were driven.

Among other factors noted by Mr. Warner as being prejudical to the stability of earthwork on these alluvial sidehills is that of wind action in trees standing above the disturbed ground. He says that any engineer who, on a windy day, has looked through a transit set up in a spruce or tamarack swamp and tried to set a hub will appreciate the extent of ground movement induced by the wind in the trees, magnified by the leverage of the trunks and acting through the shallow spreading root system. With trees on a sidehill the movement is not so perceptible because of the greater firmness of the soil. But the leverage exists and where the continuity of the surface is broken by a railway cut within a certain distance of the trees there comes a time when a wedge of earth, waterlogged and lubricated by continuous rains, will yield to the influence of the swaying trees and slide bodily downhill into the cut. For this reason, and apart from other considerations, he suggests that it is desirable that the right-of-way should be cleared from the edge of cuts on the uphill side for a distance equal to one or two times the depth of the cut.

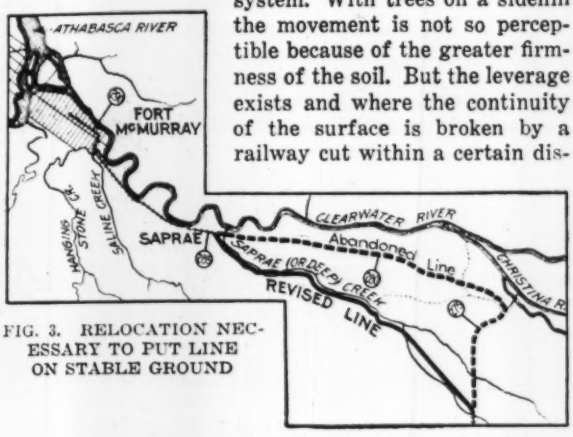


FIG. 3. RELOCATION NECESSARY TO PUT LINE ON STABLE GROUND

Large stumps left standing close to the edges of cuts were also found to be prejudicial, having slid into cuts during or after prolonged spells of wet weather. It is probable that with the cutting down and killing of the tree and consequent shrinkage of the stump and roots from the surrounding soil, in combination with the removal of the surface vegetation, water would penetrate the fissures thereby created. The distance from the face of the cut to these fissures being relatively small, percolation and scour would rapidly increase until the soil supporting the stump becomes practically a lubricated wedge which will slide into the cut under the weight of the stump. For this reason stumps near the uphill edges of cuts should be removed, the holes being backfilled with good material or the slopes of the cut trimmed back sufficiently to eliminate them.

Construction and Relocation

This line was originally graded in 1915, but rails were not laid till the winter of 1917-1918. Considerable sliding and subsidence which had occurred in the meantime had to be remedied before the track could be laid.

FIG. 2. TRESTLE WRECKED BY MOVEMENT OF HILLSIDE

During 1918, while the line was in operation, sliding still continued, and extensive works of trestling and grading were undertaken. The slides had to be removed by hand, as it was impossible to hold a steam shovel on the track. All this work, however, was without avail, the disturbance of the ground which it involved seeming only to aggravate the condition. All further work on the hill was therefore abandoned.

When the railway came into the possession of the provincial government, in July, 1920, a thorough investigation was made, the problem being to maintain a line on a sidehill composed of what was virtually a plastic material and which was furthermore subjected to rapid and destructive scour when exposed to the action of running water. This study led to the conclusion that it would have been much easier to cope with such conditions when building the line originally, but that as so many points of weakness and instability had developed in the hillside as a consequence of the presence of the existing works it would be cheaper to rebuild the line on a new location than to reconstruct the existing line. This conclusion was supported by the fact that the railway was a pioneer line of relatively cheap construction, unballasted and but half finished, running through an unsettled country where land was practically of no value and the cost of right-of-way not an item for serious consideration. Therefore the line could be diverted without detriment to any existing settlement and without any expense other than that of new construction.

A location was accordingly run down Deep Creek, which crosses the existing line at Mile 273 and flows into the Clearwater River at Mile 284 (see Fig. 3). The banks of Deep Creek for the first four miles are low and gently sloping, of good material and lightly timbered with poplar and spruce. For the remainder of its course, however, its valley deepens rapidly and its topography and materials are more like those prevailing on the Clearwater. But as it is possible to lay the line all the way in the valley bottom the character of the banks is not an important factor. As the material is not disturbed it is not likely to slide down on the track, and as the track is on a sidehill it cannot slide laterally.

The distance by the diversion is 2.8 miles shorter than by the old route, but a heavier grade had to be adopted in order to keep the line in the valley bottom. For the first 6½ miles the grade is a slack 1 per cent, the next three miles having a 2 per cent grade and being figured as a pusher grade on a 1 per cent line. For the present density of traffic, however, this latter section will be more economically operated by doubling the hill.

Experience on this line emphasizes the desirability of avoiding sidehill location on rivers in alluvial country wherever possible. Mr. Warner suggests, however, that the following precautions should be taken when a water level route by a subsidiary stream cannot be secured or when development cannot be avoided by a high crossing, so that a sidehill location becomes essential.

1. Where there is a choice of two banks, choose the bank with the sunniest aspect.
2. Fit the grade line to the ground so as to have daylight in all cuts, as far as possible. Put trestles in all sags, so as to avoid any but low embankments.
3. Clear the right-of-way to such a width as will let in ample sunlight and air.
4. Clear away all moss and old debris on right-of-way, sowing grass seed if necessary to protect surface from denudation.
5. Clear out all buried or obstructed channels.
6. Remove all stumps from edges of cuts and all trees near enough to cuts to induce sliding.
7. Provide ample culvert capacity for drainage and do not attempt to divert the natural drainage except where absolutely necessary.
8. Make culverts of metal or masonry, with ends protected by rip-rap or wing walls. If timber culverts are used they should be paved or floored to prevent scour.
9. Maintain the velocity of the drainage water through cuts and along the upper side of fills within such a limit as not to scour the material. In cuts, this way requires the use of track boxes to get the water away from the ditch in intermediate points. For fills, the remedy is to use sufficient culvert openings. Where it is impossible or economically undesirable to increase the number of relief openings, so that the velocity is liable to exceed the safe limit, the ditch should be paved throughout the portion affected by such increased velocity.
10. Thoroughly drain all pot holes and water reservoirs above and below the track to the limit of the maximum sphere of influence.
11. Above all things, watch carefully at all times for scour in drainage channels, and take steps immediately to counteract such scour.

Brick Paving Filler in Ohio

Records compiled by the National Paving Brick Manufacturers Association of contracts awarded for brick pavement construction, since Jan. 1, by the Ohio Highway Department and by the counties and municipalities of that and neighboring states, give information as to the trend of engineering preferences in design on a state-wide scale. For every 10 miles of brick-paved state highway 6.4 miles will be asphalt-filled and 3.6 miles cement-filled; 2.9 miles will be laid on rolled bases, 4.2 miles on the regulation concrete, and 2.9 miles on green concrete bases. All municipal construction for which contracts are so far awarded will be asphalt-filled on concrete bases.

Summarizing all state, county and municipal contracts, the percentages are:

FILLER—	Asphalt	68.0 per cent
	Cement	32.0 per cent
BASES: —	Rolled	28.5 per cent
	Concrete	71.5 per cent

Six miles out of 10 among the county contracts will be asphalt-filled and the same proportion holds true in respect to the amount of brick upon rolled bases.

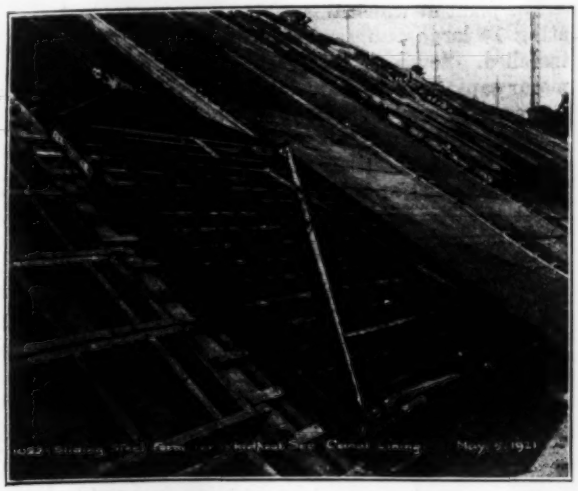
Sliding Form for Lining Chippawa Power Canal

THE power canal for the new Queenston-Chippawa development around the Canadian side of Niagara Falls is being lined with concrete throughout its length of about nine miles. In that part nearest the Whirlpool, where the canal is trapezoidal, 54 ft. deep and with side slopes of 1 on 1¾, the lining is now being placed behind a movable form of steel plating which is pulled up the slope so that the concreting is continuous for a given vertical strip.

In this section the concrete is placed up the slope for a distance of 83 ft. from the bottom. At the beginning the method adopted was first to place by ordinary methods 3 ft. strips of concrete up the slope at 18 ft. centers, and to fill the space between these strips by using wooden panels, 3 ft. wide by 16 ft. long, attached to the panels by anchor bolts. The left-hand three panels in the view show this system in operation.

LINING THE WHIRLPOOL SECTION OF THE QUEENSTON-CHIPPAWA POWER CANAL

To get away from the carpenter work entailed by these forms, the steel screed was later devised. This screed or sliding form is 16 ft. long by 17 ft. wide, and is made up of one thickness of ¼-in. steel plate, with a 9-in. channel around the outside and reinforced with 9-in. channels placed horizontally across the plate at 9 in. centers. The drawbar is a continuation of the side channels brought together about 6 ft. ahead of the form. A hand winch was placed at the top of the slope and from this a five-part line of ⅜-in. steel cable, was attached to the form by 2 five-sheave steel blocks.



STEEL SLIDING FORM IN PLACE ON CANAL SLOPE

In use, approximately 20 ft. from the bottom is poured in each panel behind the regular forms and allowed to set. The steel form is then placed on this and commenced moving slowly up the slope, the concrete placed being kept almost even with the top. In warm weather and with the concrete kept reasonably dry, it has been possible to pour a distance of 55 ft. up the slope in 10 hours. By the time the plate has passed over the concrete, it will be set sufficiently to stay in place. The result is a much more uniform face than with wood forms and a better chance to finish, as finishers can get on so much sooner, and work on green concrete.

The opposite view shows a general view of the work with one of these steel forms in operation. In this picture the green concrete behind the form can be plainly seen in contrast to the fully set concrete placed by the wood panel forms. The finisher can also be seen following the form as it goes up, only one man being required for all the finishing work necessary. The view above shows a close-up of the form. It also shows two completed pours where the superior finish of the work done with the steel form is plainly evident. The lower portions of these pours was placed with wood forms and the picture shows the off-sets at the panel joints which do not appear at all in the upper section where the steel form was used.

This method of handling the work was originally proposed by James Leith, the foreman in charge, and the idea was perfected and put in successful operation by George Angell, general superintendent. The canal and power plant is being built under the direction of H. G. Acres, hydraulic engineer of the Hydro-Electric Power Commission of Ontario, which is carrying out the development.

Engineers on Union County Park Commission

A temporary park commission for Union County, N. J., has been created to make a survey and report on a park system for the county, to be voted on next November. Two of the members of the commission are engineers—these two, residing in Cranford and Summit, respectively, are Charles Hansel, consulting engineer, New York City, and Caxton Brown, of the Weston Electrical Instrument Co., Newark, N. J., Appointments were made by a judge of the State Supreme Court.

Experience With Gas Rivet Heating in the Pacific Coast

Shipyard Results Show Better Rivets and Saving of Time and Cost—Possibilities for Structural Work

By Letson Balliet
Consulting Engineer, San Francisco

DURING the war, shipyards of the Pacific Coast, particularly in the San Francisco Bay district, substituted gas for oil and coke as fuel for rivet heating. When the yards became accustomed to gas, it was applied in a very economical way and the men learned to like it better than other fuels. The practice spread to other fields, and now there are numerous instances of gas rivet heating in structural steel shops. It is even being suggested, and with good reason, that there would be economy in heating rivets with gas in the erection of steel frames of large buildings, using a single gas-pipe riser with taps serving manifolds for flexible hose at the desired levels.

Considering the chemical process of combustion, the accurate control of air supply possible with gas makes the ideal conditions much more nearly attainable than in the case of other fuels. Full efficiency in air control has never been attained with oil, coke or coal, and in practice about 20 per cent excess air is common, and 50 or even 100 per cent excess is often found. Hot spots in the fire and burnt rivets result, and much heat is lost. With fuel oil, the usual method of spraying the oil into the combustion chamber with compressed air generally gives a severe oxidizing fire, of low efficiency; proper combustion chambers are rare, any brick-lined box in which the fuel can be burned being accepted as satisfactory.

The Air Supply

With solid and liquid fuels as ordinarily used the cost of delivering the compressed air may be more than the cost of the fuel. Largely on this account, while a dollar's worth of gas does not contain as many heat units as there are in other fuels yet it supplies more utilizable units for a given over-all expense.

The gas mixing machine is to the gas rivet heater what the compressor is to the oil rivet heater. The mixing machine is connected to the gas feed pipe and operated by a small motor. Once set up it requires no more attention than an electrically driven air compressor. It automatically governs its gas and air intakes to suit the demand, and if no gas is being used the gas meter does not move.

Simple and inexpensive mixing machines were brought out during the war as a means to greater efficiency in shipyards and other industries where gas was used extensively. These mixers are equipped with a rotary fan blower or compressor, having two intake ports, one drawing in air and one taking gas, adjustable to admit the proper relative quantities. In one type the primary mixture is made only partly combustible, and a bunsen burner with an adjustable throat of venturi-tube design supplies the required secondary air with great accuracy. This is the less expensive type. The other makes a complete mixture at the start and has back-fire arresters at the burners.

Rivets are not heated by gas as rapidly as with oil fuel, but allowance can be made for this by putting a

few extra rivets in the box when maximum speed is required. Three types of gas forges are common. The more popular type weighs about 120 lb. and has a firebox of plate steel lined with firebrick and served by gas through a ¾-in. hose. In this forge the hot rivets are turned out at the rate of three ¾ x 2½-in. rivets per minute, when using 244 cu.ft. of gas per hour. With a forge of this sort there is very little loss from burnt rivets. In fact when gas was installed at the plant of the Moore Shipbuilding Co. at Oakland, Cal., and oil- and gas-fired forges were worked side by side, the piles of rivets rejected on account of pitting or burning showed about 4 to 1 in favor of gas.

The quality of gas-heated rivets is much superior to those fired with other fuels because they are subjected to a soaking heat in a reducing fire and are soft throughout. They drive easier, fill the hole better and permit a riveter to drive more rivets in 8 hours. Tests made at the Moore yard show that gas-heated rivets have 2 to 6 per cent greater tensile strength than rivets heated by other fuels. The gas burner is always ready. It can be lighted with a match without wood kindling, is free from smoke, fumes and waste, and saves the time lost in starting or cleaning fires. There is no annoyance in keeping watch of the supply of fuel on hand and ordering more in time to avoid delay. Supply, storage, and delivery problems are all solved at once and there is no surplus to be hauled away when the job is finished. Another advantage in the shipyard is that a gas torch can be operated from the same supply line that serves the forge, with which to heat an angle or bracket that must be "flanged" or "knuckled" to fit closely in a corner.

In the plants converted to gas rivet heating, if the compressor equipment was previously sufficient to supply oil burners, when gas was adopted enough compressor capacity was released to double the number of riveting guns. Conversely, a smaller compressor is required upon the job which uses gas, and of course a correspondingly smaller energy charge or steam requirement.

COMPARATIVE RIVET HEATING COST, USING THREE FUELS

For Each Rivet Pot per Eight Hours	Oil	Coke	Gas
Cost of fuel delivered on job	$0.96	$1.43	$1.20
Distribution of fuel to fire from storage	.62	.81	.....
Truck, wagon, hauling in yard to hull	.20	.36	.....
Motor power compressed air at 1c. per hp.-hr.	.80	.64	.....
Air overhead yard leakage and operation	.80	.64	.....
Coke boxes, upkeep, delivery, etc	.....	.15	.....
Clean up, oil, ashes, burnt rivets, etc	2.10	.52	.03
Supply and delivery of kindling for fires	.....	.30	.....
Rivet gangs lost time, starting, adjusting fires	.64	1.28	.32
Rivets burnt (or lost in ashes) at 7c. lb	3.50	2.10	.14
Destroyed coke sacks (burnt, cut or lost)	.....	.30	.....
Operation gas mixers, power, etc	.....	.....	.08
Auto truck-hauling ashes to dump	.....	.06	.....
Time of ship cranes handling coke and coke trays	.....	.07	.....
Time of ship cranes handling empty and full ash bbl.	.....	.09	.....
Laborers' time picking bolts and rivets from ashes	.....	.05	.....
Lost bolts, nuts, rivets in ashes	.....	.....	.....
Paint barrels, rope handles for ashes	.....	.03	.....
Lost time cleaning fires and rekindling	.....	.64	.....
	$9.62	$9.47	$1.77

The accompanying tabulation of expense incidental to rivet heating, from one of the shipyards of the San Francisco Bay district, gives an excellent comparison of fuel costs. Oil is figured at 6c. per gallon, coke at $26 per ton, gas at $1 per 1,000 cu.ft. and 16 gal. of oil is taken as the equivalent of 110 lb. of coke or 1,200 cu.ft. of gas per 8-hour shift. In the gas cost no piping charge is included, as this item has a high salvage value and was not charged against each job in the shipyard.

The plant at which this table was compiled was operating 14 large compressors when the gas forges were installed. Seven of these compressors using 3,300-hp. motor capacity were dismantled and sold when 300 gas forges replaced that many oil and coke forges, the amount realized on this sale being enough to pay the cost of the gas installation. The power bill was reduced between $4,000 and $5,000 a month, which practically offset the gas bill. Thus the yard made a net saving equal to the entire cost of coke and oil used in rivet heaters.

Gas is now being used for rivet heating in a number of structural-steel fabrication shops on the Pacific Coast. Its use in the erection of large steel-frame buildings has been proposed but not yet tried. On construction jobs, a 2-in. riser could be carried up the elevator shaft or up any convenient post with manifolds vcut in to serve flexible hoses supplying forges at the several levels. The derrick or elevator would be relieved from the necessity for hoisting fuel and lowering ashes and this time-saving for the hoisting equipment could be measured in terms of more structural material handled.

Elastic Viscous Deformation Expressed By an Exponential Formula

Shearing experiments on pitches, asphalts and similar materials by P. G. Nutting of the Bureau of Standards have led him to establishing an exponential formula including both force applied and time of action as factors of the resulting deformation. As reported by him at the recent annual meeting of the American Society for Testing Materials, the formula is,

$$s = at^n F^m$$

in which s is the deformation, t is the time during which the shearing force F acts, and a, n and m are constants. Ordinary viscous deformation would have $n = 1$ and $m = 1$, but for pitch and asphalt of various kinds these exponents were found to have different values. Purely elastic deformation corresponds to $n = 0$, $m = 1$, and the author therefore suggests that the formula may prove to be so general in form as to be applicable to most kinds of stress = strain relation.

For a particular hard stearine pitch the exponents were determined as $n = 0.56$, $m = 2.0$. The range found in testing various pitches, tars and asphalts was $n = 0.40$ to 0.91; $m = 0.74$ to 2.0, the time exponent being less than unity in every case. A high value of m was interpreted as showing a rubbery texture, and a value less than unity a texture resembling quicksand, the deformation increasing less rapidly than the applied load.

For determining the constants of the formula a steel tongue 50 × 100 mm. was inclosed in the material to be tested, held between parallel steel plates 2 mm. distant from either face of the tongue, and the tongue was pulled out of the material by the action of a weight. With careful control of temperature, measurements could be made to within one per cent, and results could be duplicated very closely.

Truck Operation Costs on Grades

Record of the cost of operating passenger automobiles of large capacity, running out of Los Angeles, show that for a given car and load, averaged over long periods, the entire cost of operation over paved roads on fairly steep grades is very close to 33 per cent more than the cost of operation on the level. While the same holds true for other similar runs, records of the bus companies show that the Bakersfield and San Diego runs illustrate this cost relation very well. The former involves a climb of about 5,000 ft. while the latter is practically level.

Colorado Rainfall Records and Flood Estimate

Intense Local Precipitations East of Mountains and Succession of Local Floods Reported by Officials

RECORDS of the Colorado rainstorm of the first week of June have been collected by J. M. Sherier, meteorologist of the U. S. Weather Bureau at Denver, and through his courtesy are made available herewith. On the map Fig. 1 are given the total precipitations for June 1-4 and June 1-7 inclusive. They indicate that an extremely heavy rainfall was localized in the region east of the Continental Divide and, in fact, east of the Front Range. The total precipitation over the larger part of the region was 2 in. to a maximum of 11.44 in., the latter being recorded at Colorado Springs. The following discussion of this rainfall is given in Mr. Sherier's own words.

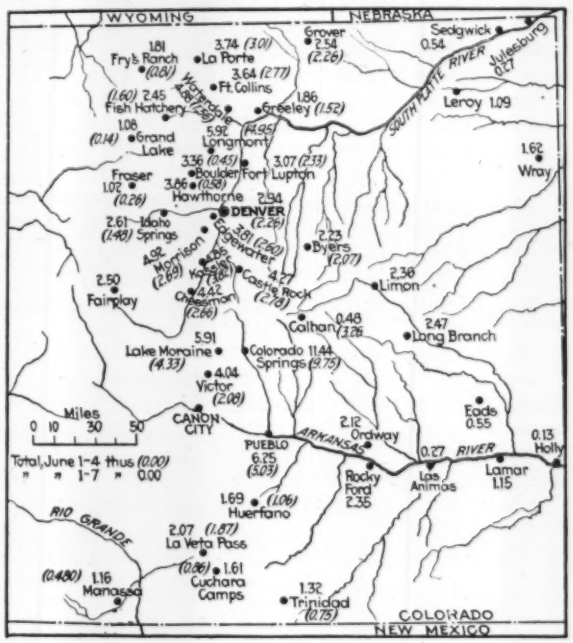


FIG. 1. RAINFALL MAP OF CENTRAL COLORADO

"While the precipitation was everywhere heavy near the mountains, no very unusual amounts occurred in the eastern portion of the state. This is also true of the western slope. The flood at Pueblo was due not so much to a heavy general rainfall as to terrific downpours over limited areas, some idea of the intensity of which is indicated by the record from Colorado Springs, where it appears that 9.40 in. of rain fell between 3:30 p.m. of the 3rd and 2 a.m. of the 4th. This opinion is supported by every local engineer with whom the matter has been discussed.

"Although such a rain as occurred at Colorado Springs would alone have caused a serious flood if it had extended over any considerable area, the disaster at Pueblo was due principally to a so-called cloudburst at Swallows, about 12 miles west of Pueblo, on the evening of the 3rd, of which there is no exact record. The river rose rapidly from a stage of 5.6 ft. on the morning of the 3rd to a crest at 1 a.m. of the 4th that has been fixed by the state engineer at 24.66 ft. After the passing of the crest, the stream fell rapidly and is reliably reported to have been at a stage of approximately 14 ft. at 4:30 a.m.

"Unfortunately no rainfall data has been received as yet from Canyon City. The highest river stage reported from that place, however, was 9.0 ft., or 1 ft. below the flood stage, and it was assumed excessive precipitation did not extend so far westward."

State Engineer's Study of River Flow

An investigation of flood phenomena by the state engineer's office is still in progress. On account of the great demand for information, however, a preliminary report has been made by R. G. Hosea, deputy state engineer, to A. J. McCune, state engineer, which brings together essential flood-stage and river-flow data concerning the Arkansas River and Fountain Creek. In connection with his report Mr. Hosea emphasizes that the flood was not caused by the failure of any reservoir dam, and that the Schaeffer reservoir dam failed about 10 o'clock Sunday morning, June 5, while the peak of the flood at Pueblo occurred about 1:30 a.m., June 4, more than 30 hr. previously.

COLORADO RAINFALL RECORD FOR JUNE 1-6, 1921
(Daily Precipitation in Inches)

	June 1	2	3	4	5	6
Grover	.....	0.34	0.62	1.30	0.16	T
Fry's Ranch	.....	.....	0.67	0.14	0.20	0.10
Laporte	.....	0.66	0.47	1.88	0.47	0.26
Ft. Collins	.....	0.24	1.07	1.46	0.25	0.02
Greeley	.....	.....	0.90	0.62	.....	0.30
Waterdale	.....	0.07	1.56	.....	0.52	0.24
Fish Hatchery	.....	0.20	0.28	1.12	0.45	0.20
Grand Lake	.....	0.14	T	T	0.10	0.60
Longmont	0.10	.....	4.40	0.45	0.44	0.48
Fort Lupton	.....	0.02	1.36	0.95	0.35	0.04
Boulder	.....	.....	0.31	0.14	.....	0.71
Hawthorne	.....	0.58	.....	.....	2.10	0.71
Fraser	.....	.....	0.09	0.17	0.08	0.41
Idaho Springs	.....	0.14	0.20	1.16	0.59	0.32
Edgewater	0.08	.....	2.15	0.45	0.48	0.60
Denver	T	0.10	0.75	1.41	0.37	.....
Morrison	.....	0.23	0.40	1.98	1.60	0.40
Kassler	.....	0.14	0.17	3.51	0.52	0.36
Byers	.....	0.35	1.38	0.34	0.10	0.06
Castle Rock	0.06	.....	2.78	.....	0.50	0.18
Cheesman	.....	0.34	0.10	2.22	1.07	0.49
Calhan	.....	.....	.....	3.26	0.83	0.39
Colorado Springs	.....	0.35	5.00	4.40	1.26	0.42
Lake Moraine	.....	.....	0.65	3.68	1.40	0.18
Victor	.....	.....	.....	2.08	1.55	0.37
Pueblo	.....	1.94	1.64	1.45	1.12	0.09
Huerfano	.....	.....	.....	1.06	0.56	0.04
La Veta Pass	.....	.....	0.98	0.89	.....	0.20
Cuchara Camps	.....	.....	.....	0.86	0.21	0.13
Manassa	.....	.....	.....	0.48	0.36	0.13
Trinidad	.....	.....	0.20	0.55	0.30	T

The drainage areas of the two rivers and their principal tributaries are marked out on the accompanying map, Fig. 2, which forms part of the report mentioned. The territory shown contributed practically the entire amount of flood water which passed Pueblo, according to the conclusions reached. The following flood facts are taken from the report.

Flood Stages at Pueblo—The flood rise of the Arkansas at Pueblo began about 11:30 p.m., June 2, when the river rose from a flow of 8,100 sec.-ft. to 28,500 sec.-ft., corresponding to a gage height of 13.7 at 2 a.m., June 3, but by 8 a.m. the water had receded to 5.5 ft., with a 3,500 sec.-ft. discharge, and dropped considerably more by noon. A sharp rise began at 5 p.m. raising the stage 6.2 ft. to 11.2 ft. in little over an hour, with 18,000 sec.-ft. discharge, and after con-

tinuing slow rise of the stage the peak flood rise began at 7:40. An hour later the stream overflowed the stone coping of the levees (18.14 ft.), and quickly flooded the city. Despite the increase in flow area, the river continued to rise, to about 24.66 ft., or 6 ft. over the sidewalk of the Main St. Bridge. The water then receded, and by daylight, 4:30 a.m., was just below the levee top. A flood in Fountain Creek also developed during the night of June 3, of sufficient violence to tear out nearly every bridge below Colorado Springs; its maximum probably did not reach Pueblo until the morning of June 4, after the crest of the Arkansas flood had passed by.

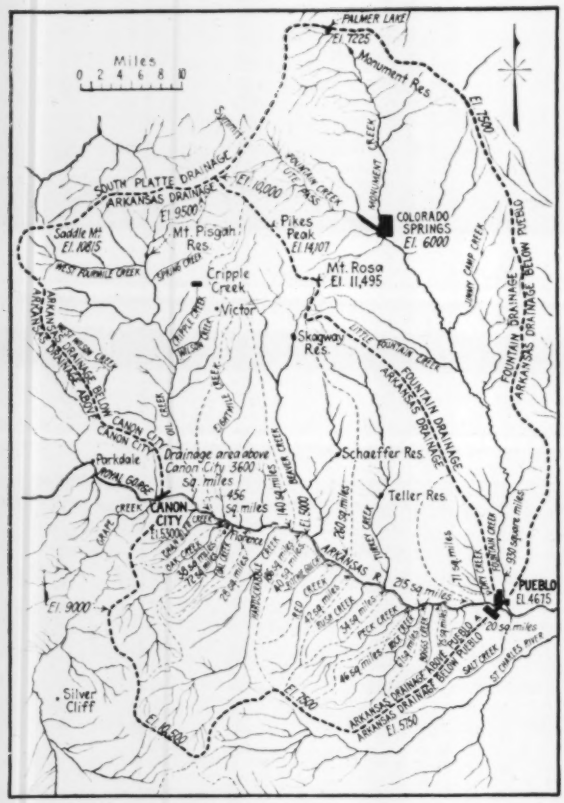


FIG. 2. DRAINAGE-AREA MAP OF PUEBLO REGION

The Arkansas rose again, a lesser amount, in the afternoon of Sunday, June 5, due to the flow of the discharge of the Schaeffer reservoir failure. The dam, an earth structure, gave way about 10:30 a.m., discharging its entire storage volume of 3,100 acre-ft. The gage height reached at Pueblo in this wave is not recorded, but it was far below the Saturday peak.

Gagings were made by H. D. Amsley and G. C. Price, state hydrographers at Pueblo, in the morning of June 2 and the afternoon of June 3, which gave a check on the discharges corresponding to low and ordinary flood stages. Discharges at other stages were estimated from these, and were checked by the Chezy formula with coefficient calculated from the Kutter formula for the slope of 13½ ft. per mile and roughness factor 0.0225.

Mr. Hosea estimates the capacity of the channel under the floor of Main St. bridge (16.85 ft.) with 2,300 sq.ft. waterway, at 41,000 to 45,000 sec.-ft. This flow could be carried only if the stream were free from debris; the floorbeams of the bridge go down to 14.67, which stage corresponds normally to about 33,000 sec.-ft. discharge. At 13 ft., allowing some 20 in. clearance under the floorbeams, the channel is estimated to have only 25,000 sec.-ft. capacity. The peak flow of the night of June 3-4 is estimated at 100,000 sec.-ft. (believed to be a liberal estimate).

The peak flow of Fountain Creek is estimated at 50,000 sec.-ft. (for channel 400 ft. wide by 10 ft. deep, slope 30 ft. per mile between Colorado Springs and Pueblo, velocity 12 ft. per sec.). The estimated maximum for La Junta is 172,000 sec.-ft., corresponding closely to a flow of 170,000 measured at the Amity dam, some 30 miles farther downstream. The crest of the flood reached La Junta at 3:15 p.m., June 4, 13¾ hr. after the Pueblo peak. This gives a figure of about 5 miles per hour for the movement of the flood wave downstream.

The total quantity of water discharged through the Pueblo streets (i.e. outside the river channel) is estimated at 20,000 acre-ft.

Canyon City reports indicate a maximum flow of only 4,200 sec.-ft. at 9 a.m., Saturday, June 4 (this is after the peak passed Pueblo) and it is stated that the storm did not extend 3 miles west of Canyon City. In the afternoon of June 3 there was a very heavy storm in the drainage area between Canyon City and Pueblo, and this same storm covered the upper Fountain Creek area, with 5.00 in. fall at Colorado Springs, followed by 4.20 in. more between 2 a.m. and 6 a.m. of June 4. The storm was very heavy to the south, and it was from the Siloam and Boggs Flat country that Pueblo was first warned of the coming of a flood. The St. Charles River carried a very large flood but the Huerfano was not unusually high. These facts indicate clearly the local storm nature of the Pueblo flood.

On the north side the Teller reservoir stored practically all the flow of Turkey Creek, which showed no signs of unusually high water at its mouth. The Schaeffer reservoir also held back the flood of Beaver Creek until after the Pueblo peak.

Mr. Hosea makes the following preliminary estimate of flood peaks:

Stream	Sec. Ft. Peak Discharge
Arkansas River at Pueblo	100,000
Fountain Creek at Pueblo	50,000
Salt Creek	1,000
Chico	2,000
St. Charles	10,000
Huerfano	2,000
Apishapa	1,000
Timpas	1,000

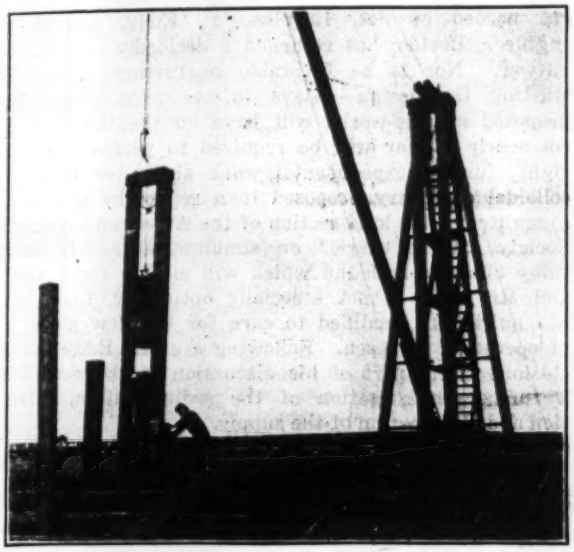
Slope measurements are to be made to give a further check on the computed discharges. Extensive damage done to irrigation structures, particularly due to shifting of the river channels, is to be reported upon later.

Lehigh Has Course in Ship Construction and Marine Transportation

A course to prepare men for the field of ship construction, marine transportation, and foreign trade is offered by Lehigh University, Bethlehem, Pa. In addition to studies in engineering, shipbuilding, and naval architecture, the course includes a considerable amount of study in business and economics, such as finance, accounting, business law, foreign exchange, marine insurance, economic geography and foreign trade. One of the requirements for graduation is that students spend a summer at sea following their junior year.

Piles Driven Through Wharf Roof 90-Ft. From Fender

THE destructive action of marine borers recently made it necessary to replace with creosoted piles about 3,000 untreated piles in a wharf at Port Costa, Cal., some of the replacements being as far as 90 ft. from the fender line. This wharf is built parallel with

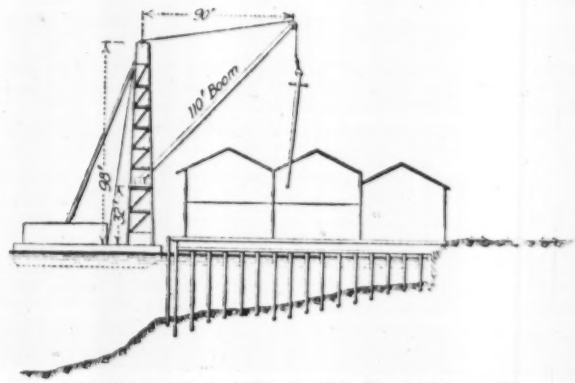


DRIVING THROUGH ROOF WITH SUSPENDED LEADS

the shore line. The driving had to be done with floating equipment for three reasons; (1) the wharf has a superstructure upon it, (2) piles of considerable length were required, and (3) it was desired to carry out the work without interfering with the storing and moving of freight on the wharf. The piles were driven though openings made in the roof and in the floor for this purpose, using a scow piledriver with a 110-ft. boom set in the tower. The boom was used first to place the piles and then to support a hammer and pair of leads for driving them.

Work was done on only a small section at a time. A space about 32 x 40 ft. in area was cleared of freight on both main and second floors and roofing and flooring was opened up in this section to make way for the new piles. The driver used has a tower 98 ft. above the deck of the barge. At a point 32 ft. above the deck it has a step in which a boom can be set when desired. For use on this work a pair of 15-ft. leads with a 4,400-lb. hammer were suspended from the end of the boom, the hammer being operated by a line running through a sheave at the boom end to the head block and thence to the winch drum. The usual procedure was to set about 25 piles with the boom and then to suspend the hammer and leads from its end and begin the work of driving. This process was repeated, moving such freight as was necessary, until the work was finished.

Piles 55 to 85 ft. long were used and were driven to refusal. They were placed on 8-ft. centers in bents spaced 12 ft. apart, the allowable load being taken as 22 tons per pile. For convenience in shifting to a new hold on the pile when this was necessary after it was lowered through the roof, an 8-ft., 6 x 8-in. timber was chained to the pile as a crossarm near is upper end.



POSITION OF DRIVER WHEN PLACING PILES

The piles were driven as close to the cap as possible and after driving were cut off on a slight bevel at the exact level desired and pulled under the caps where they were wedged tightly into place and fastened by drift bolts driven through the cap. With this rig the rate of progress was about 10 completed piles per 8 hours.

The contract on the work was held by the Healy-Tibbitts Construction Co. of San Francisco. Information from which the foregoing was compiled was supplied by B. C. Gerwick, engineer for the contractor.

Standard Specifications Helpful to the Municipal Engineer

From the presidential address of George S. Webster before the American Society for Testing Materials, read at Asbury Park on June 21 under the title "The Influence of the Work of the American Society for Testing Materials Upon the Execution of Public Works."

The adoption of standard specifications has proved to be beneficial to the consumer in that it has enabled him to secure a more uniform and higher grade of material at a lower cost than would otherwise be possible. The standard has been evolved as a result of the collective work of the leading experts on the subject and it is common experience that the composite work of many experts is far more valuable than that of a single expert.

The ability to obtain materials of a specified quality has reduced the cost of construction because in the use of the material by reason of the better knowledge of its properties, economies can be effected which would not otherwise be possible. The producer, by reason of uniform standards, can operate his plant uniformly in turning out a standard product, and thereby effect economies in the cost of production.

Politics Eliminated and Test Methods Fixed

Probably no consumer of building materials has benefited to a greater extent as the result of the adoption of standard specifications than has the municipality. In the construction of public works there are many influences which render such work difficult, not the least of which is the political influence. The adoption of the standard specifications of this society eliminates a great deal of undesirable controversies and undesirable competition and results in a greater efficiency in the expenditure of public funds. Where standard specifications are formulated in the manner as are those of this society, all producers are aware of the fact and can offer less objection to the specifications than would be the case if the specifications, no matter how meritorious, were prepared by the employees of the municipality.

As I review my experience in passing upon materials, I am impressed by the fact that nearly all the controversies that occurred over materials that had to be rejected, related to the methods used in testing the materials. With

the establishment of recognized standard methods these controveries have decreased and with the growing respect for the specifications used there has been less attempt to secure the acceptance of inferior materials, and this has resulted in a marked improvement in the work.

It would be impossible for a municipality to undertake to carry on the research necessary for the development of specifications as is possible through such an organization as the American Society for Testing Materials. Through the membership of its employees in this society and on its committees, the municipality can have the advantage of the experience of the many experts serving on these committees and participating in the general discussions at the annual meetings. The inevitable result of these meetings is the broadening and an ever-widening experience of those who attend with a consequent increased service to the municipality. It has been my practice to encourage assistants connected with the work under my charge to become identified with the society and to participate in its work.

Rule-of-Thumb Selection

In the early days of engineering in this country, materials of construction were for the most part passed upon by the engineer by rule-of-thumb methods and later experience has shown how very deceptive such methods are as an indication of quality. For example, it was formerly a practice to test the quality of cement by placing the mortar between two bricks and the quickness with which the bricks would adhere together was an indication of the quality. It was usual years ago in sewer construction to use natural cement in laying the bricks and this quick-setting material showed a rather superior quality in this respect to portland cement, which set much more slowly. Sand was tested by rubbing it in the hands to see whether it was dirty, and determining whether it was otherwise suitable by visual methods. Those who are experienced in testing know how utterly inefficient and aburd such methods are.

The advantages to the municipality through the adoption of the standards of the American Society for Testing Materials may be briefly stated as follows: (1) Ease in specifying the quality of the material required, (2) ease in testing materials delivered under the specifications through the use of standard methods, (3) ease in obtaining standard products, (4) an effective means for minimizing controversies over purchases of materials, and (5) a feeling of security that the materials used are satisfactory, as a result of the knowledge of how the standard specifications are formulated and that they reflect the latest knowledge and experience.

Mole Hole Drains Without Tiles

Drainage of wet agricultural lands by means of mole holes or mole drains, as practiced in England, consists in forming drains in the soil, without the use of pipe or tile, the process being limited to soils in which the holes or drains will retain their shape. For making the drains, there is a machine consisting of a frame slung below the axle of a pair of large wagon wheels and carrying a steel plate or colter which extends down into the soil. To the bottom of the colter is attached a cylindrical steel mandril or plug, behind which is a similar but slightly larger plub to compress and smooth the walls of the hole formed by the plug. The depth at which the drain is formed can be regulated by an attachment for raising and lowering the colter. This machine is hauled across the land by a cable and hoist, the soil at once closing in to fill the narrow slot cut by the colter. A very similar process used in this country has the important advantage of placing tile in the hole by means of a carrier following the colter, so that the system is applicable to various kinds of soil (see *Engineering News*, March 30, 1916, p. 615.)

A New Study of the Milwaukee Water-Supply Situation

Low Typhoid But High Child Mortality—Sewage-Works Will Reduce Average Load on Water Filters But Flood Overflows Menace

As a result of a new investigation of the water situation from the standpoint of whether filters are needed or not, Harrison P. Eddy, consulting engineer, Boston, has returned a decidedly affirmative answer. Nor is he favorable to further delays in starting the design—delays to see what effect the proposed sewage-works will have on the lake water. As nearly a year will be required to perfect the designs, further experimental work along the lines of colloidal chemistry proposed in a report by a special committee of the local section of the American Chemical Society can be carried on simultaneously. If anything of value is found which will modify the design, and Mr. Eddy is not especially optimistic, the plans can quickly be modified to care for the new methods of operation proposed. Following are Mr. Eddy's conclusions and a part of his discussion of the need for a further investigation of the sedimentation, filtration and chlorination of the supply.

Health Indices—Vital statistics indicate that the health conditions in Milwaukee compare favorably with those of other American cities where the health standards are reasonably high.

Typhoid fever, which was high in the earlier years, has been reduced materially by improvements in the water supply. Mortality among young children is somewhat higher than would be expected if the city were provided with an absolutely uncontaminated water supply. Notwithstanding the vigilance of the water department officials in protecting the water supply and the painstaking work of the health department, both of which have had so beneficial an effect as to place the city in an enviable position with respect to the general public health, there are indications that the quality of the water supply is such as to affect somewhat unfavorably, although much less so than formerly, the health of the city, particularly as regards intestinal diseases.

The change of intake, December, 1912, resulted in a distinct improvement in the sanitary quality of the raw water.

All Sewage Cannot Be Treated

Because of rapid changes resulting from wind currents and the flushing of sewage into the lake, the quality of the raw water is such that its purification requires the utmost vigilance in order to prevent infectious matter reaching the consumers. In addition to the pollution derived from the sewage of the city, there is opportunity for pollution from bathing beaches, lake traffic and industrial wastes, these sources of pollution being of relatively minor importance, although by no means to be neglected, as compared with the city's sewage.

The proposed treatment of the sewage, aside from practically eliminating the present exceedingly objectionable foul condition of the rivers and shore waters, will, under normal dry weather conditions, materially reduce the amount of sewage contamination reaching the intake. Notwithstanding the excellent results of sewage treatment which are assured, there will continue to be bacterial contamination of the waters of the bay by the treated sewage, but this contamination can be so controlled as not to exceed that caused by the discharge of the untreated sewage of a population of one-tenth that of the city.

Flood Menace—In times of substantial rain or melting snow untreated sewage will be discharged from the intercepting sewers into the rivers and from the sewage-works directly into the lake. The quantity of such storm over-

flows will vary from small to great volumes according to the intensity and duration of the storms, but in all cases the waters discharged will contain not only the filth washed from the streets and other surfaces but also a portion of the sewage of the city. The frequency of such overflows will depend upon the number of storms causing them. It is reasonable to expect upwards of 60 occasions per year or an average of five per month. The quantity of untreated sewage so discharged will vary according to the intensity and duration of the storms and the contributing population. On the average in 1925 it may amount to 4.4 per cent of the entire normal sewage flow for the duration of the storm. At times of intense storm it may be as great as 90 per cent or over, of the entire sewage flow. Storm overflows will frequently be of short duration, although on some occasions the discharge may continue for many hours.

Filters Needed for Worst Condition

Even after the sewage-works shall have been put in operation, the continued though greatly reduced contamination of the lake water will be a menace to the sanitary quality of the water supply. The treatment of the sewage will assure a raw water generally well within the accepted safe limit of contamination for purification in a thoroughly effective dependable water purification plant. Nevertheless, the relative change in conditions which the water purification plant will be called upon to meet apparently will be practically as great although much less frequent than before sewage treatment.

Filters vs. Chlorine—Chlorination alone has undoubtedly been of marked benefit in reducing typhoid fever and other intestinal diseases in Milwaukee, and so long as such chlorination is carried on effectively and uninterruptedly there should be no recurrence of excessive typhoid, although a few cases may occur now and then, resulting from a small amount of infection escaping the chlorination process. A filtration plant built and operated according to present generally accepted good practice is more dependable and a greater safeguard to the health of water consumers than chlorination alone.

Filtration followed by chlorination will afford even greater protection than either process alone and is fully justified at Milwaukee. Filtration will give a clear, physically attractive water and one of relatively uniform quality for disinfection, thus assuring satisfactory bacterial removal even with materially reduced amounts of chlorine and therefore with less probability of objectionable tastes and odors.

Colloidal Chemistry — Notwithstanding the great advancement which has been made during the past twenty-five years in the purification of contaminated municipal water supplies, it is possible that further substantial improvements may be accomplished by the application of the principles of colloidal chemistry. The more delicate control of the hydrongen-ion concentration, which may be popularly called acidity of the water, appears theoretically to offer some adantages. Such control, however, is clearly in the experimental stage of development and must be very thoroughly investigated and tried upon a relatively large scale before its adoption can be justified. The promise of advantage from application of the principles of colloidal chemistry is sufficient to justify Milwaukee in forthwith making preliminary laboratory investigations, and if these indicate material advantage the city is fully warranted in making investigations upon a relatively large scale to demonstrate the practicability of the new methods. If it should prove practicable to utilize the new methods, it is possible that greater filter efficiency would result and that permissible higher rates of filtration would warrant a material reduction in the size of the filter plant.

What Colloid Study Might Show

The committee of chemists was of the opinion that the practical application of the principles of colloidal chemistry to the problems of sedimentation and filtration will have an important influence on the treatment preparatory to filtration. To take advantage of the hydrogen-ion concentration in the operation of filters it will be necessary to control the chemical treatment in several steps: (1) Quantity of alum required for successful treatment must be determined. (2) The P_H value must be ascertained. (3) The amount and kinds of chemicals must be learned to produce the isoelectric point. Since water varies as to bacterial content, organic matter, micro-organisms, turbidity, and temperature as well as P_H value, such control involves extreme care, particularly as the variations are sometimes frequent and sudden.

Five advantages appear possible from P_H control: (1) Prevention of after-deposits; (2) elimination of corrosive action; (3) control of small plant and animal life; (4) possible reduction in plant size due to speedier filtration of water containing a floc formed at the isoelectric plant; (5) possible increase in efficiency.

If it be assumed that all of the advantages can be secured—a very improbable assumption—it does not appear likely that any material change will be required in the design of a plant to be operated in this way, as compared with a plant designed to operate according to the older and well-established methods, except that some reduction may be possible in the size of coagulation basins and in the extent of filter area. Such other changes as may be necessary would appear to be of a minor nature, such as in chemical tanks, pipe lines and dosing apparatus.

Status of Federal-Aid Roads

OF THE 22,030 miles of federal-aid roads which have been built or were under construction March 1, 1921, more than two-thirds are earth roads, sand clay, or gravel, according to a recent statement by the chief of the U. S. Bureau of Public Roads. These have cost less than one-third of the total amount expended, as compared with nearly 50 per cent of the estimated cost applied to 4,890 miles of hard surfaced roads.

For the 22,030 miles of highway, extending into every state, the total estimated cost is $361,946,868. The percentage of this total estimated cost which will be incurred for each type and the mileage of each type based upon the records of plans approved, are shown herewith.

	Per Cent of Total Estimated Cost	Mileage
Type 1, including earth, sand, clay and gravel	32.2	15,300
Type 2, including water bound and bituminous macadam	9.0	1,530
Type 3, including brick, bituminous concrete, Portland cement concrete	48.8	4,890
Miscellaneous	4.0	310
Bridges	6.0	.....
	100.0	22,030

Many times the question has been asked the bureau, What type of road is best? The answer is always the same: There is no one best kind or type of road surface. A recent statement issued by the officials of the bureau expresses this thought in the following language: "It is the policy of this bureau to consider the conditions on each individual federal-aid project, as there are elements such as subgrade, drainage and present and prospective traffic, which vitally affect the determination of the standards of construction to be used."

There have been occasional attempts to write into state laws or the governing conditions of bond issues a requirement as to the type or kind of roads to be constructed. To follow such a course the bureau believes, would be most unfortunate. This principle was recently expressed to a chamber of commerce asking for information, in the following language: "Types of highways should not be specified by law. This is a matter to be decided by the state highway department in which should be lodged full authority both to construct and to maintain. Competition between different types of material should be maintained and selection made to fit traffic requirements in each case.

Methods of Checking Erosion of Farm Lands in Iowa

Brush Dams and Tile Drains Reduce Destructive Flow After Rains and Promote Filling of Gullies by Sediment

As heavy rainfalls cause extensive gullying of soft surface soils in rough and rolling country, means of preventing such erosion and restoring the surface have been studied by the Iowa State College, with results as outlined in the following abstract of a report by M. H. Hoffman, formerly extension professor of agricultural engineering.

Overfalls or vertical falls of water which work back through the land are the cause of 90 per cent of the gullying, the remainder occurring where cattle tramp in the mud of overcrowded pastures or where sidehill ditches are washed in cultivated land. Some of these gullies are 40 to 50 ft. deep and of equal width. Most of them carry water only during rains. Their annual progress is from 30 to 300 ft., depending on the slope and rainfall, but they stop on reaching a point where the flow is so small that the current does not dislodge the grass. Meantime, side ditches have developed and form a special trouble, for while land may be farmed on both sides of the main ditch, the others cut it into small, irregular pieces.

Methods for Filling Gullies

The loose soil which is 15 to 30 ft. deep along the Missouri River thins out as it extends across Iowa, and erosion is at its worst where only a few feet of this soil covers the glacial drift. In the southern section this soil has somewhat greater tenacity, but there is trouble from erosion in the 10 to 12 ft. of alluvial soil in the valley land. A single rain has developed a crack 12 in. wide, 6 ft. deep and 240 ft. long, which later rains in the same season enlarged to 8 ft. in width and depth and more than 480 ft. in length. Approximately 1,100 cu.yd. of soil were lost from this ditch in one month.

For filling a gully, the work should begin both at the upper end to check the overfall and at the lower end to catch the soil that comes down. The former usually is not difficult or expensive if immediate repair is made after rains. A satisfactory method is to set posts in the ditch about 2 ft. from the overfall, these being spaced 2½ to 3 ft. apart and sloped downstream. Straw is packed on the bottom and up against the bank, being kept in place by a layer of green brush intertwined between the posts and held down by crosstimbers spiked to them. The obstruction should not be higher than the banks as it would then turn the stream around to the sides, forming more overfalls. Good results have been obtained by stretching a wire fence across the ditch 6 or 8 ft. below the fall and packing the space above it with bundles of cornstalks set on end. In some cases the steep fall of the valley and hillsides makes it desirable to install plank, concrete or stone chutes.

After checking the overfall, the ditch is to be filled to such a level that it can be crossed by teams and farm implements, leaving a shallow rounded channel in order to prevent new gulleys. A tile drain is the first and most important step, for where water flows it is impossible to get root growth established firmly enough to hold the soil. In eight years a rough ditch that had been tiled was filled from 5 to 7 ft. and could be crossed with farm implements. The drain should be placed below the bottom of the ditch, not alongside it, and should follow the general course but smoothing out the sharp turns. As tiles 1½ to 2 ft. below the ditch may be washed out by a heavy rain coming before the fill has compacted, it is advisable to secure them by X-braces of stakes against which straw is packed before the trench is filled.

After the drain is established, low obstructions should be built in the ditch bottom. For Iowa conditions the most successful have been those from 1 to 2 ft. high and spaced 30 to 90 ft. apart. A common method is to set posts in the form of a V with the vertex downstream, straw being then packed on the bottom and against the sides. On this is laid brush with butts upstream held down by boards nailed to the posts. Old woven wire fencing packed with straw may be used where brush is not obtainable. The top of the obstruction is made concave to keep the current in the middle in times of high water. When a fill of 12 or 18 in. is formed new obstructions should be placed half way between the old ones. If the obstructions are too high at first there is danger of undercutting and sidecutting by the water impounded. Planting willows is not advisable as they do not form sufficient obstruction and their roots are likely to clog the drain.

Dams of plank, concrete and stone have been unsuccessful, the water usually washing out one end and so getting underneath. A dam would stand if built with a footing several feet below the bottom of the ditch, its ends well into the banks, the middle considerably lower than the ends and with a downstream curvature of about 120 deg. The Iowa Highway Commission has a design for use where the culvert must be low to take the tile water but where erosion will result unless flood water is held back. Surface washing on hillsides has carried away large quantities of soil, but except for the bluff land along the rivers it is a question whether the use of terracing is advisable.

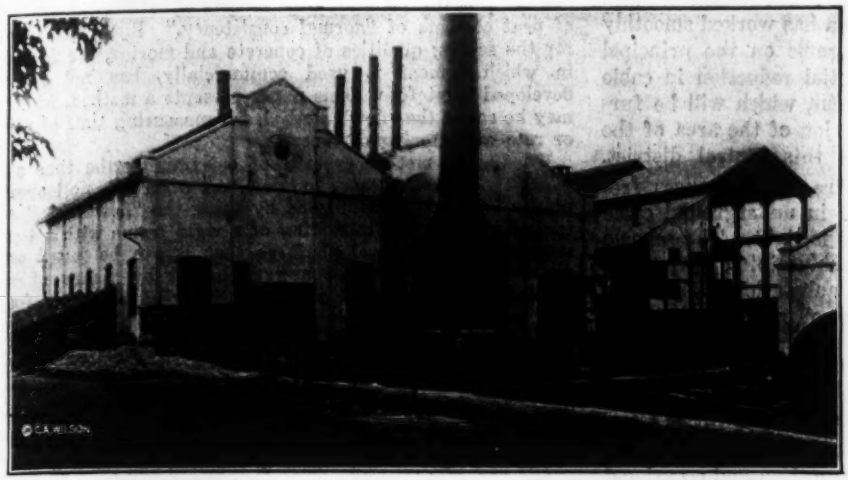
Sink holes occur in the extreme northeast part of Iowa. Usually a crevice in the underlying limestone allows earth to drop through and be carried away by the underground stream, until the surface soil falls in, forming a cavity 5 to 15 ft. deep and 20 ft. or more in width. There is usually a hole at the bottom through which soil disappears in time of rain and in which livestock is occasionally lost. If such sinks are filled with logs and brush the earth keeps sliding in. Plugging with stone and concrete stops drainage and causes mud holes. A successful method is to cement a tile into the hole in the rock and build a vertical drain of tile with loose joints. In heavy rains the water first flows over the top of the tile, leaving the dirt behind, and as the pools lowers the water escapes through the pipe joints. Some of the larger drains need to be provided with a manhole grate, but many can be capped 2 ft. below the surface and then covered with soil.

Cost of Canadian-Niagara Hydro-Electric Power

In an address before the Toronto Board of Trade, visiting the Queenston-Chippawa power development around Niagara Falls, Sir Adam Beck, the chairman of the Hydro-Electric Power Commission of Ontario, made a statement last week regarding the probable cost of power in the new development. He said the estimated cost of the Chippawa development, based upon cost of labor and materials in 1920 and 1921, was $60,000,000, and the plant would have a capacity of 500,000 hp. When this development is finished the total amount of the investment in the whole "Hydro" system would be not less than $210,000,000. The total electrical energy purchased and generated by the commission is 440,000 hp. The capital cost per horsepower at the Ontario Power Co.'s and Electrical Development Co.'s plants at Niagara is $135, whereas the capital cost of Chippawa power on the above basis would be $125. This means $12 per horsepower delivered compared with the cost of steam generated power, which is between $60 and $70 per horsepower. Sir Adam suggested a reciprocal arrangement should be made between the United States and Canada under which, pending the completion of the Chippawa canal, Ontario would borrow unused power developed in the American plants and after the canal had been put into operation, "Hydro" could turn over some of its Chippawa power to American users on short-term leases, which, he said, would ease the burden on the Ontario municipalities.

First Portland Cement Mill in Straits Settlements American Built

AN AMERICAN equipped cement mill at Singapore is the first to produce portland cement in the Straits Settlements. It is known as the Ho-Hong Portland Cement Works and was designed and constructed by James C. Muir, M. Am. Soc. C. E., who is engineering representative of the Robertson-Cole Co. and general manager of the works. The photograph of the mill reproduced herewith has been furnished by C. A. Wilson, Cambridge, Mass., who has been traveling in the Far East.



AMERICAN EQUIPPED CEMENT MILL AT SINGAPORE, STRAITS SETTLEMENTS

The mill was built by coolie labor, under the direction of Mr. Muir, in the midst of a swampy jungle with the tide overflowing all the grounds and nine miles away from the unloading of heavy machinery. It has an output of 1,100 bbl. per day and it is expected to increase the capacity to 5,000 bbl. to meet a growing export demand, according to Mr. Wilson. All of the machinery for the mill, clay digging, and pulverizing coal for the kilns came from the United States. American machinery is also used in a barrel factory run in connection with the mill.

It is stated by Mr. Wilson that throughout the Far East there is a growing attempt to supply the naturally large demands for cement construction. He believes that American machinery should be in great demand. Both India and Ceylon are making portland cement.

Southern Pacific Lays Manganese Rail

The first shipment of 15 per cent manganese rails on an order placed by the Southern Pacific Railroad for 2,000 tons, has been laid on the Tehachepi grade in California. Rail wear over this pass has been very rapid because a large portion of the grade is on sharp curves, the ruling curve of 10 per cent being frequently used. Under these conditions 90-lb. A. R. A. standard rails on the inside of curves have to be renewed on an average of every 18 months. The decision to use manganese rails was made in an endeavor to minimize interruptions which are particularly objectionable on this grade because the heavy traffic of two transcontinental railroads is here carried on a single track line. The manganese rails are costing about 4½ times as much as common rail.

Electrolysis Conditions Relieved at Winnipeg, Canada

Three-Wire System of Electric Railway Improves Ground Return—Alkaline Soil Another Cause of Pipe Corrosion

CORROSION of cast-iron water mains by stray currents from the electric railway at Winnipeg, Manitoba, has been relieved by the introduction of the three-wire system of distribution, as an improvement upon the older two-wire system of insulated negative return feeders. The following account of the local situation and development is summarized from an extended paper in the *Electric Railway Journal* of March 26, 1921, p. 584, by W. Nelson Smith, consulting engineer for the Winnipeg Electric Railway Co., who has designed and supervised the carrying out of the entire scheme for reducing the track potentials and gradients to the prescribed legal limit. This corrosion has been the subject of long controversy between the company and the city. In 1915, the late Prof. Ganz made a report to the Manitoba Public Utilities Commission, recommending the establishment of limits of track-potential differences, with permanent means of observing them, an additional substation and insulated negative-return feeders on the old two-wire system. These recommendations, somewhat modified, were embodied in the Manitoba electrolysis act and were accepted by the company in an agreement with the city in 1918. A study of the situation by Mr. Smith showed that owing to the heavy cars and light rails the same amount of copper would go much farther if used on the more modern three-wire system, which was also more convenient for final adjustment in equalizing track potentials. The three-wire system had been applied successfully on a large scale at Los Angeles, Cal., in 1915 (after Prof. Ganz had made his Winnipeg report). In 1918 it was in use also at Brisbane (Australia), Omaha and Milwaukee, besides being proposed at Springfield, Mass., Wilmington, Del., and New Orleans.

In the sectional method adopted at Winnipeg for three-wire operation, the alternate sections of any double-track or single-track line are of opposite polarity. The general plan of sectioning is to set off three zones from each substation to the extremity of its feeding district, and to reverse the middle zone. This arrangement offers the lowest reduction of track potential combined with a tendency of stray currents in underground cables to flow continuously toward the substation, as compared with any other system of sectioning. Mr. Smith states that after more than a year of operation in one district and several months in two others (including the central district) there is no reason to revise the general arrangement of sectioning. Line failures are rare and in extreme emergency everything can be paralleled on the two-wire system if necessary.

Tests made in May, 1919, in the first district (Fort Rouge) showed that the reduction of track potentials between the substation and the principal outlying points was from an average of 11 volts under two-wire operation to 3 volts under three-wire operation, a reduction of 73 per cent. These results were considered to warrant the extension of three-wire operation to the remainder of the system. In October, 1919, it was applied to the St. Boniface district and showed a reduction of the potential from 10 volts under two-wire operation to 4 volts under three-wire operation. On July 1, 1920, three-wire operation was begun in the central district and the system has worked smoothly under congested conditions of traffic on the principal streets. In this district the initial reduction in cable drainage current was 62½ per cent, which will be further reduced owing to the reduction of the area of the present zoning arrangement of this central district.

Cable Drainage—The three-wire system causes frequent reversals of stray current in underground cable sheaths in districts where traffic is light. The scheme of cable drainage contemplates maintaining all present drainage connections into the substations but when necessary it is proposed to use small negative boosters, or "suckers," of about 1-kw. capacity, each with resistances in series, if needed, to assist in determining the inward direction of cable drainage current. The plan is subject to the approval of the Public Utilities Commission.

Alkaline Soil Corrosion—Deterioration and occasional destruction of underground structures of concrete by alkaline salts in the ground water has been so widespread in western Canada that Mr. Smith made an investigation as to the effect of such solutions upon cast iron and lead, with and without access of stray electric current. The laboratory results and examinations of pipes in areas where stray current does not exist indicate that soil conditions are responsible for part of the pipe corrosion at Winnipeg.

Power Transmission by Pulsations in Water

A new system of power transmission which is being developed in England and which has been applied to the operation of rock drills, riveting machines and gears for the automatic firing of airplane guns, consists in imparting wave motion or rapid pulsation to liquid contained in a closed pipe. This system differs from hydraulic transmission in that the column of liquid need have no continuous flow. The power generator is a multi-cyclinder high-speed reciprocating pump, the motor also having cylinders and pistons to receive and utilize the pulsations. In the generator as now built a horizontal shaft carries eccentrics with rods pivoted in trunk pistons to which the smaller pump plungers are attached, these pumps being placed horizontally at both sides of the shaft. For rock drill work, there are 2,400 to 3,000 pulsations per minute, with a pressure of 750 to 1,500 lb. per square inch. Flexible steel pipe for carrying the column of liquid to the motor or tool is composed of short sections put together with spherical joints. The cost of operation by liquid wave transmission is said to be very much lower than for compressed air. This system is the invention of George Constantinesco, a Roumanian engineer, and the apparatus is manufactured by W. H. Dorman & Co., engine and machine builders, of Stafford, England.

Time of Set of Concrete Studied by the Flow Table

By Watson Davis
U. S. Bureau of Standards, Washington, D. C.

Abstract of paper presented to American Society for Testing Materials, Asbury Park, N. J., June 22, 1921.

The "time of set" of concrete is an important property to which little attention has been given. Specifications for the time of set of neat cement, the principal active ingredient of concrete, have been formulated and used. Much investigational work has been done using the Vicat and Gillmore-needle methods of measuring time of set of neat cement, and the literature is filled with reports of setting time tests of neat cements of "normal consistency." But a measure for the setting qualities of concrete and mortar, the forms in which cement is used commercially, has not been developed heretofore. This paper presents a method, which may be called the "flow" method, for measuring time of set or rate of stiffening of concrete.

Briefly, the method consists of determining the time at which the concrete ceases to "flow," or when it is no longer plastic. This is accomplished by using the "flow table," a table-like apparatus consisting of a rigid frame with a top mounted on a vertical shaft so that it can be jolted or allowed to drop through a fixed height by means of a rotated cam. A mass of concrete, usually in the shape of a disk or truncated cone, is placed on this table top, jolted a given number of times, and its increased diameter measured by means of calipers. The diameter after jolting divided by the original diameter and multiplied by 100 gives a figure which is a criterion of "flowability" or consistency.

How Set Is Measured

The flow test for consistency of concrete and the flow test for time of set of concrete are intimately connected. In the test for time of set, the rate of decrease in flow is measured as follows: A number of disks of concrete are molded and at stated time intervals after mixing are tested in succession for flowability. At the beginning of the test the disks are jolted at intervals of an hour, but the intervals between joltings are decreased as the flow decreases. As the concrete stiffens the flow decreases, and the time at which the point of no flow is reached is considered the time of the set of the concrete.

Effect of Consistency on Set.—That the wetter the consistency the slower will be the set seems to be a general law, so long as cement, mix, and aggregates are the same. In every case in the data obtained an increase in initial flowability of a given mix is accompanied by an increase in the time of set. Except for the influence of the setting quality of the cement itself, excess water producing wetter concrete is the most important factor influencing the time of setting of concrete. The retardation of set is most marked in the leaner mixes.

Effect of Richness on Set.—A rich concrete will set faster than a lean concrete provided the two concretes are of the same consistency or initial flowability and are made of the same materials. The effect of richness on set is minimized when the consistency is so dry that only a small decrease in flowability is necessary to cause the concrete to reach the point of no flow or to become set.

Effect of Character of Cement on Set.—The character of the cement is undoubtedly the most important factor that influences the setting time of concrete. Variation of gypsum content, method of manufacture, raw materials and fineness all affect the setting properties of the cement and these properties of the cement are reflected in the concrete in which the cement is used.

While the setting properties of the cement determine in a large measure the setting properties of the concrete, in general, the differences between the setting times of concretes have a tendency to be less than those between the setting times of corresponding neat cements.

Relation of Time of Set of Neat Cement and Concrete.—As pointed out above, neat cement sets faster than the concrete made from it. Conditions of temperature, aggregate, cement content and consistency materially affect the

setting time of concrete, and while the setting properties of the cement as determined by a needle test on a neat mix of normal consistency are reflected in the concrete, they are changed and influenced by the conditions peculiar to the concrete. For these reasons it is believed that to determine the setting properties of concrete, tests must be made on the concretes themselves.

Effect of Temperature on Set.—Concrete at "low" temperature (35 deg to 40 deg.) took over 2.5 times as long to set as that at high temperature (95 deg. to 110 deg. F.) and the concrete of normal temperature (70 deg. F) set 4 hours before the cold concrete, and 1½ hours after the "high" temperature concrete Strength tests on 3 x 6-in. cylinders kept 24 hours under the different temperature conditions were made and the average of three tests at 24 hours under each condition showed that at high temperature the strength was 2.5 times normal temperature strength and at low temperature the strength was one-sixth that at normal temperature.

Various Conditions of Set

While it is possible that concretes made of cements of different composition and manufacture would not always exhibit these large differences in set and strength due to temperature, undoubtedly the results presented are indications of what may be expected. In general the lower the temperature the slower a given concrete will set, and the higher the temperature, the faster it will set.

Method of Measuring Set of Neat Cement.—Results indicate that the flow method gives times of set that are somewhat earlier than those for initial set given by the Gillmore needle. The tests indicate that time of initial set by the Vicat needle is about the same or slightly earlier than the initial set by the Gillmore needle. The flow method of measuring time of set is fundamentally different from the Gillmore and Vicat methods. In the Gillmore test only a portion of the outer surface of the pat is tested. The Vicat test depends upon the penetration of a needle into a relatively small portion of the pat. When the flow time-of-set piece is jolted on the flow table, the entire mass is affected.

The flow method could be used for routine setting tests of cement. Two set test pieces could be made of normal consistency paste and one tested at 1 hour and the other at 7 hours. Provision could be made that a flow of 105 should not be reached when 1 hour old but that it should be reached by the end of 7 hours.

Incidentally it is believed that the flow table is a better apparatus for use in determining "normal consistency" of neat cement than the Vicat apparatus.

Nature of the Flow Changes Occurring During Setting.—The rate of the change in flowability that takes place during the setting seems to be influenced by the consistency and cement content of the mix. When the mix is of small initial flowability or is rich in cement content, a large part of the flow (50 to 75 per cent) is lost in the first hour after mixing. When the mix is of wet consistency and has a small cement content, the decrease in the first hour after mixing is smaller on a percentage basis, but during this first hour the rate of decrease is usually higher than during any other period. A probable explanation of these initial decreases is that they are caused by a combination of setting and absorption. The cement and aggregate gradually absorb water during this period, thereby doing their share in decreasing the flowability.

Tests show comparatively rapid decrease in flowability determined at short intervals (3, 5 and 10 minutes) after mixing, showing that there is a stiffening of the mix due to absorption in the first few minutes during and after mixing. While this absorption of water is comparatively more rapid in the first 10 minutes during and shortly after the mixing, the absorption is probably not completed then. Although diminished, it probably continues through the first hour or more after mixing, and combined with a true setting action, causes the initial decrease referred to above.

Early Strength as a Measure of "Final Set."—That flow time of set corresponds approximately to the initial times of set by the needle methods when used for neat cement has been shown in data presented above. But the final set tests by the needle methods can be applied only to neat cements, and even then are of no real use and require much time to complete. The test needed is one that will tell the condition of the concrete at an early age and give definite information that can be used in deciding when to pull forms, or to perform some other operation. A compressive strength test at an early age, say 24 hours, will give such information. A test of this kind is suggested as a substitute for tests of final set.

Use of Flow-Set Method.—Probably the chief use of this method of making time-of-set determinations of concrete will be in investigational work in concrete to determine the effect of various factors on set. It is also capable of being applied practically. This is shown by the following example:

A floor was being laid, and a 1:2 mortar topping accelerated by using a calcium-chloride solution for gaging liquid was used for one portion, while the rest was laid with mortar gaged with plain water. Flow set determinations were made and the opinion of the finishers was obtained. This test brought out the fact that a mortar of a flow of about 190 could be wood-floated, while when it had a flow of about 140 it was in about the right condition to finish with a steel trowel. Once these flow constants were determined for the table and mold used, preliminary tests could determine very closely the time at which floating and finishing could be begun.

There is a certain minimum consistency or flowability of concrete that can be used for certain purposes, such as in a reinforced-concrete building, and the length of time that the concrete retains a flowability greater than the minimum can be determined by the flow method.

Undoubtedly this method of measuring time of set can be applied to measuring the rate of stiffening of limes, plasters, clays, etc., and other plastic materials.

Other Factors Affecting Set.—Factors other than those already investigated undoubtedly affect the time of set.

The kind of aggregate, depending largely on its absorptive properties, will probably be found to influence the setting. Concretes made of absorptive clay, slag, and stone aggregate will brobably set faster than similar concrete made of non-absorptive quartz aggregates.

Similarly, the moisture condition of the aggregate will tend to affect the set of the concrete. Wet aggregate will probably make the setting relatively slower, while dry aggregate will probably accelerate it slightly.

The gradation of the aggregate, the fineness of the sand and the relative amount of coarse aggregates may have some effect on set, and this is a field for future study. The change in setting time caused by the addition of different salts, admixtures and proprietary compounds may be determined by the method described.

It is believed that humidity has little effect on set, although no correlated data are presented on this factor. It should be noted that the whole test specimen is used in the flow-set test, and that for that reason, surface drying caused by low humidity probably does not materially affect the result. Humidity probably does affect the results of the Gillmore and Vicat methods of determining the time of set of neat cement as these tests are made on the surface rather than the body of the test specimen.

Dock Improvements for Port of London

With extension of the Royal Albert docks already begun, London water-front facilities are to be extended by the Port of London Authority at an estimated cost of over £14,000,000 for the purpose of attracting to that port a portion of the Transatlantic trade now handled through Liverpool. A floating landing stage 1,700 ft. in length, adjoining the Midland Ry. station at Tilbury, will be provided, with a 35-ft. depth of water at low tide. Additional docks at Tilbury will provide 600 yd. of quay with 42-ft. depth of water. The quay will be completed equipped with freight-handling machinery and trackage. Extensive dry dock facilities will also be provided.

Bamboo Reinforced Concrete Piles for Bridge Foundations

CONCRETE piles reinforced with bamboo rods were used in 1919 by the Szechuan-Hankow Ry., of China, on account of the high cost of steel. These piles were for the foundations of 65½-ft. spans to replace arch culverts with shallow footings which had been washed out by a flood from the Han River. Timber piles were not suitable as there is a 40-ft. seasonal variation between high water and low water. The piles were 10 x 10 in., 22 ft. long, made with a 1:2:4 mix, using ½-in. stone. For steel reinforcing there were four bars from ½-in. square to ⅝-in. diameter (according to material available), with ¼-in. hoops and wire wrapping. The following particulars are taken from a paper in the *Journal* of the Association of Chinese and American Engineers by C. J. Carroll, chief engineer of the Szechuan-Hankow Ry.:

Three designs of the bamboo reinforced piles were made: (1) four vertical strips ⅞ in. wide, split from green bamboo poles, placed 1 in. from each corner and bound with telegraph wire and ¼-in. iron hoops; (2) two bamboo strips lightly wired together were placed in each corner and bound as above, the point and head of the pile being stiffened by a 36-in. length of old boiler tube; (3) eight vertical bamboo trips at the corners and the center of each face were secured by bamboo square hoops one foot apart, a few ¼-in. iron hoops and two 36-in. pieces of boiler tube being used also. This last construction appears to be the most satisfactory. The piles were cast in nests of eight forms and after four days were removed carefully to a storage yard where they remained for at least a month.

In soft blue clay at the first bridge, piles with both steel and bamboo reinforcement were driven easily, although 24 to 36 in. of hard material was encountered at about 18 ft. A 1-ton hand pile driver was used, with a drop of 3½ to 5 ft. until the hard stratum was reached. For experimental purposes the drop was then increased until the top of the pile was shattered. Both kinds of piles would break under a few blows of over 10-ft. drop, the break extending usually not over 3 ft. from the top.

Bamboo Piles in Soft and in Stiff Clay

In stiff blue clay at the other bridges the piles were driven slowly and with difficulty as a 6½-ft. drop of the 1-ton hammer would give only ¼-in. penetration. When the full penetration of 20 ft. was reached, the drop was increased until the pile head was shattered. Piles with bamboo reinforcement took the shock as well as, if not better than, those with steel reinforcement. Care must be taken to have the bamboo in exact position, as some piles failed by shattering of the concrete where the reinforcement had been so displaced that it did not give proper support. Piles 10 x 10 in. and 30 ft. long were driven in an open caisson. A driving cap was used 11 x 11 in. and 3 ft. long, built of ¼-in. steel plates and hoops, with a 3-in. angle across the middle so that the cap dropped 18 in. over the pile. The upper end was packed with old rope, paper and sawdust, a hardwood block extending a few inches above the cap to take the hammer blow.

A 50 per cent saving in cost was effected, the cost for material and labor being about $28 per pile with steel reinforcement and $14 with bamboo. Piles of Oregon pine cost $14 delivered. It is thought that for lengths up to 22 ft. the bamboo-reinforced piles are satisfactory for foundation work, and on long new lines of railway they will reduce the trouble and cost of transporting reinforcement. It is suggested that bamboo reinforcement concrete may be used for temporary work in cofferdams and falsework and that piles may be fitted with pipes for jetting, but caution must be exercised in the design of beams or slabs, especially when subject to tension. Laboratory tests will probably be made at some of the technical colleges of China.

Notes From Foreign Fields

INDUSTRIAL DEVELOPMENT IN THE HOLY LAND

By A. E. Kornfeld

IT SEEMS a pity to disturb the tranquility of the Holy Land. It is strange to see camels and donkeys walking on macadam roads; it seems out of place to see telephone and telegraph wires strung on the Mount of Olives, on Mount Carmel, at Tiberias, along the Dead Sea; yet this is what one encounters daily in his journey through Palestine. The modernization of the country is going on and will continue.

Agriculturally the country is being developed in an intensive manner. A number of industrial plants are being built, others are contemplated. A plant for boxing oranges for the export market, about completed, expects to ship two million boxes of oranges in 1922. A silicate brick plant at Jaffa will be in operation by July, producing 12,000,000 bricks yearly. As soon as the machinery can be set up a large quarry will be in operation near Haifa. The old King Solomon quarries, which furnished the stones malachite and limestone for King Solomon's temple, are about to be reopened.

It will be necessary to build a large hotel at Jerusalem to accommodate the many tourists that are nightly turned away from the two small hostelries here. There are a large number of unfinished buildings in the city. Some were abandoned during the war, others stopped because of financial difficulties. A superstition exists among the natives whereby they refuse to finish what proved a failure for someone else. An enterprising firm of architects and builders could purchase these unfinished structures at a low price, finish them, and rent them before they were fully completed. Houses for business as well as dwelling purposes are in great demand, and rents are abnormally high.

Harbors will have to be built at Jaffa and Haifa. Streets leading to the harbors will have to be widened. The sanitary conditions are bad in all the large cities, and only fair in the small places, owing to lack of water where it is most needed. The water is here, but engineers will have to bring it to the places where it is required. Hydro-electric plants will be built on the river Jordan, the river Auja and in Beersheba. These plants will furnish illumination for all of Palestine and run tramways if the necessity for the latter is found.

At Tiberias there is a sulphur spring and a small house, in which the Romans bathed 2,000 years ago. The water is so hot it has to be cooled before one can get into the bath. Medical men claim that the curative powers of this spring are wonderful and many chronic cases of rheumatism and skin troubles have been cured. The enterprising modern spirit would take this spring, build a bathing pavilion and sanitarium, and create a great resort; it would prove a paying investment from the day of its completion. Tiberias, beautifully situated on the Sea of Galilee, is a place of great historical value and an unfailing point of attraction for the tourists.

Roads are now being built by pioneers (refugees from Russia) who are working for their homeland; pay is

to them a secondary consideration. I am told they earn about 80c. a day. They are extremely happy and live for the most part in tents close to some colony engaged in intensive farming. Back-to-the-land movements are in evidence all over Palestine except at Beersheba and I am told a new colony is about to be organized here.

As H. T. Cory said in his recent report on the development of Palestine, the natural resources of the country are greater than those of Southern California, and Palestine can support four million people. These statements effectively outline the work that is waiting there. If Great Britain can continue to give the Zionists military protection for the next five years, Palestine will become a prosperous land both agriculturally and industrially.

There are too many engineers here now, they tell me, but I believe the ambitious American or English engineer who is willing to do pioneer work and await his opportunity, will be well repaid for his trouble. Engineers with initiative are needed. Palestine may seem a long way from home to some engineers—but mail reaches Palestine in sixteen days from New York. The climate is ideal, the people courteous, democratic and well educated. Most everyone speaks three languages, a great many five. Sir Herbert Samuel, High Commissioner for Palestine, expresses the opinion that the country is ripe for industrial development, and cordially invites American co-operation in the building of the Holy Land.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

In Defense of the Alameda Site for the Pacific Coast Naval Base

Sir—In your issues of Dec. 30, 1920, p. 1258 and June 9, 1921, p. 975, there are editorials attacking the proposed construction of the Alameda Naval Base. You state in the latter editorial regarding the Alameda Site that "It is hoped that in its revival the engineering factors will be more governing than they were in the selection of the site by the joint congressional committee." You further intimate that the choice of the Alameda site was influenced by political and not by engineering factors. It is to be regretted that a technical publication should attempt to qualify as a naval engineering authority, in competition with the experts of the Helm and McKean Commissions, and with Admiral Rodman, the man who received the surrender of the German Fleet.

The facts regarding the selection of the Alameda Naval Base are as follows:

The joint congressional committee which presented the final report selecting the Alameda Naval Base Site, was greatly influenced by the previous reports of the Helm Commission and the McKean Board, both of which, after thorough investigation, had favored Alameda above all other sites.

The Helm Commission was a committee of naval experts, consisting of Rear Admiral James T. Helm, Rear Admiral H. H. Rousseau, Chief Constructor W. L. Capps, Captain G. W. McElroy and Commander C. L. Hussey. The McKean Board which was appointed to review the Helm report, and which was even more emphatic in its recommendation of the Alameda site, consisted of the following naval experts: Rear Admiral J. W. McKean, Rear Admiral C. W. Parks, Chief of Yards and Docks, and Commander J. C. Hilton. In addition to the above reports by the engineering and constructing experts of the navy, some of the highest operating authorities of the navy, including Admiral Hugh Rodman, reported to the congressional committee that from a strategical standpoint, it would be utter folly to place a major naval base at Mare Island.

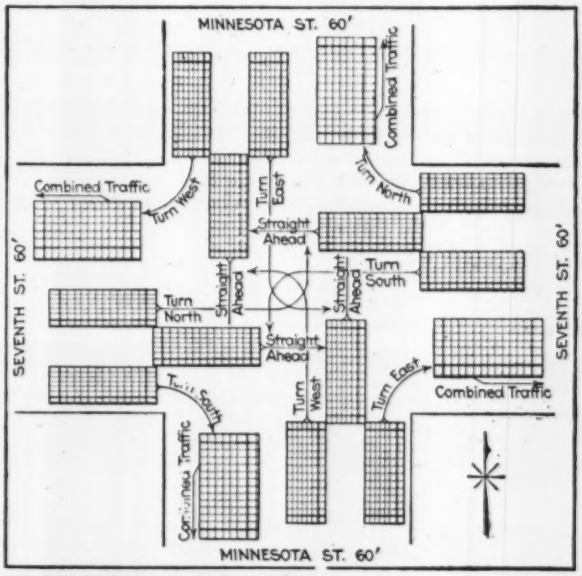
The two naval commissions referred to were officially appointed representatives of the United States Navy, the only agency really qualified to pass upon a subject involving naval matters, either as regards engineering or strategic phases.

C. E. HICKOCK,
Alameda, Cal., June 15. City Engineer.

[This journal is not posing as a naval expert. It merely favors the opinions of the naval officers and engineers who advocated Mare Island, gentlemen who are quite as reputable and expert as those who happened to be on the committees in question.—EDITOR.]

Diagram for Analyzing City Traffic Used by City Planning Board

Sir—I am sending you herewith a copy of our traffic diagram used for analyzing the traffic count made at various street intersections. This diagram has never been published, and I have never seen anything like it. It was developed in this office and affords a very comprehensive means of analyzing the traffic at a street intersection.



Hour	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	Total
P.A.	19	30	39	55	45	25	49	44	44	52	56	15	475
L.T.	11	14	16	12	10	5	10	7	12	5	11		123
H.T.		9	11	9	7	4	6	4	9	11	2	1	64
H.V.	5	6	16	15	11	7	6	15	6	12	3	2	110
Total	36	61	82	91	73	41	73	90	73	80	74	18	792
Cars													

TRAFFIC DIAGRAM, ST. PAUL CITY PLANNING BOARD

For weighting traffic the following rule applies: P.A., passenger automobile = 1 unit; L.T., light truck, = 1 unit; H.T., heavy truck, = 4 units; H.V., horse vehicle, 1 horse, = 2 units; H.V., horse vehicle, 2 horses, = 6 units; car, street car, = 7 units.

The traffic counts that have been made in connection with our city plan have been made by the graduating classes of the high schools. Two hundred and fifty to two hundred and eighty-five boys from the senior classes of the high schools were released on certain days to make this count. This enabled us to make a simultaneous count on all streets surrounding the central district.

St. Paul, Minn., April 26. GEORGE H. HERROLD,
City Planning Engineer.

HINTS FOR THE CONTRACTOR

Handy Concrete Weight for Derrick Line Cheaper Than Iron Ball

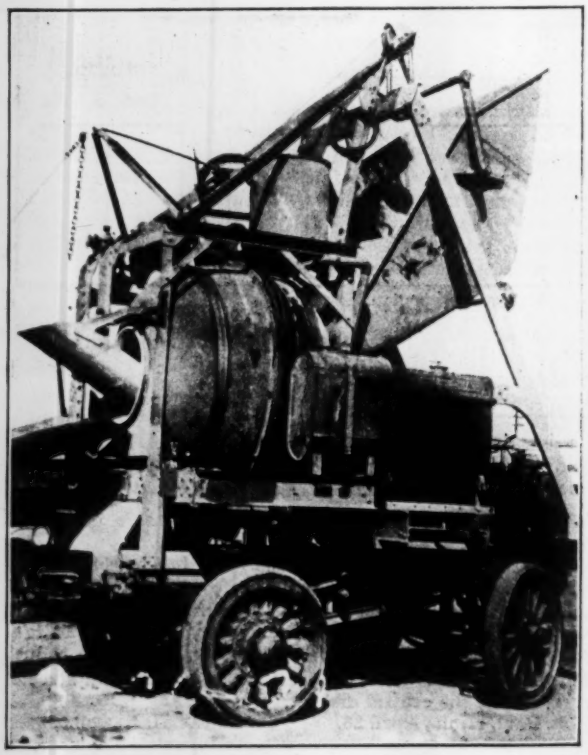
CONCRETE WEIGHT FOR LONG DERRICK LINE

AN EMPTY nail keg to be used as a form, a piece of heavy chain and a few buckets of good wet concrete are all that is required to make an excellent weight for a derrick line on structural work. The metal ball so generally used for this purpose in pre-war times is now less frequently seen on construction jobs in California and the concrete weight, as shown in the accompanying illustration, is taking its place.

Mixer Mounted on Truck Chassis

By Walter B. Cannon
Lankershim, Cal.

THE mixer illustrated has been built with the end in view of having a paver for maintenance work which could make long jumps at the speed of a truck without having the trouble of loading on a truck. Only standard parts, easily obtainable, enter into the construction. The main units were a building mixer, a 3-ton heavy aviation truck chassis, and a power plant from a four-wheel drive truck. The motor and the chassis had been condemned, but the mixer was new.



IMPROVISED MOBILE POWER OUTFIT

The mixer was set on the chassis so that the drum rolls just cleared the frame and then was riveted in place. The countershaft on the mixer was not moved, but the driven sprocket and clutch were reversed in position to bring the sprocket next the bearing, so that the driving chain would come at the small part of the drum.

On account of the increased height of the mixer, the skip could no longer tip on a pivot so a track was built from channel steel by welding. The front end of the skip was turned down to the ground so that charging barrows could be run directly under it.

The front axle of the chassis was moved back as far as possible to shorten the wheel base, and the steering gear connected to the drawbar which was hinged in such a position that it folded up out of the way while the mixer was being used. There was not enough room to get in the original steering gear so one was made out of a worm and worm gear from a grader. As the gearing is irreversible, the gear is removed when the mixer is being moved.

The original transmission was removed and one made having but one speed in each direction, shifted by one lever. The traction can be operated with the drum stationary. The speed is about one mile per hour.

The power plant was mounted as a unit on a subframe across the chassis, and a differential used to give the drive parallel with the chassis. The governor was set for about 800. The magneto was set with a fixed spark.

The bonnet was used with a partition between fan and engine to keep dust from the engine. All controls are within easy reach of the operator and a guard placed so that he cannot get his hands on the skip track. The outfit traveled 250 miles in one month.

Cement Stocked on Wheeled Platforms Moving with the Mixer

SPEED and ease of charging cement into a paving mixer were increased by wheeled platforms used in place of the usual roadside stock piles in building the Butte-Anaconda concrete road in 1920. As described in the *Concrete Highway Magazine* by J. M. Hicks, superintendent, Clifton, Applegate & Toole, Anaconda, Mont., contractors: The cement was shipped in by rail and stored in two warehouses so located as to afford the most economical haul. It was hauled to the mixer by motor truck and unloaded onto two small platforms mounted on wheels and placed on two sections of track. Each track section was long enough to accommodate both cement cars. As the mixer moved forward, the cement cars were pushed ahead with it, and when both cars were on the front section of track the back section was moved ahead. The cement platforms on the cars were 4 x 8 ft. and were about 2 ft. above the ground. Each car held 100 sacks. Because the cement was on a raised movable platform the work of picking up bags and emptying them into the charging hopper was cut down to such an extent that this job was preferred by the workmen. Before the platform was put into service it was almost impossible to keep men for this task.

NEWS OF THE WEEK

New York, July 7, 1921

Phipps Highway Bill Goes to Senate Committee

Large Majority of Senate Favors Consideration of Principles in Both Dowell and Townsend Measures

(Washington Correspondence)

The Phipps highway bill, with the Dowell rider, passed by the House, has been referred to the Senate committee on postoffices and post roads. After extended discussion, this action was taken rather than that of sending the bill to conference or of concurring in the House amendment.

When the bill was presented to the Senate June 30, Senator Townsend, chairman of the committee on postoffices and post roads, immediately moved that the bill and the amendment made by the House be referred to his committee. Senator McKellar, of Tennessee, a member of the committee who is in favor of the House bill, moved that the Senate concur in the House amendment. The House had attached its bill —the Dowell measure—to the Phipps bill which already had passed the Senate.

More Changes Probable

The discussion following the motions of Senator Townsend and of Senator McKellar soon indicated that the Senate would not allow this legislation to go on the statute books without having had an opportunity to discuss and amend it. In fact, a filibuster was openly threatened. There was every evidence that the great majority of senators were anxious to consider both the Dowell and the Townsend measures. In view of this sentiment, Senator McKellar withdrew his motion and the Senate, without a roll call, sent the House bill to the Senate committee. Senator Townsend made it clear that there would be no effort to pigeonhole the House bill in his committee.

It is evident that the Senate will insist upon material changes in each of the bills. Strong objection was voiced to any proposition which requires a state to modify its constitution and its laws so as to participate in the benefits of a federal appropriation. It was said that the constitutions of 17 states contain a provision which forbids the issuing of interest-bearing evidences of indebtedness for the purpose of making internal improvements. It was pointed out, however, that this condition would merely prohibit the states from raising the money by bond issues but would in no way preclude the securing of the fund by taxation, which would require no change in the constitutions of those states. It was

(Continued on p. 38)

To Study Timber Strength

At a meeting of lumber interests, held in New York June 21, a resolution was adopted recommending that no revision of the New York building code provisions respecting timber be undertaken until an investigation of timber strength has been carried out. It is proposed that the inquiry shall include a study of prior tests of timbers in commercial sizes, as made, for instance, by the Forest Products Laboratory. Tests on commercial timbers as delivered in the metropolitan district are recommended to check results.

Bureau of Standards to Study Housing Materials

The Calder bill prior to its passage and signature by the President on June 16, as incorporated in the general deficiency bill, was changed in the wording of that section which proposed a separate division of housing in the U. S. Bureau of Standards. It was demonstrated to the satisfaction of Senator Calder that housing involved so many studies that it would be impracticable to attempt to consolidate them into one division. Much of the Bureau of Standards' work, however, has a bearing on constructional activities. Better results will be accomplished, it is believed, by allowing those activities to remain undisturbed as they are grouped, which will interfere in no way with the correlation of the results from each of the activities. This will be possible under the provision of the appropriation for continuing the investigation of structural materials by the application of the following proviso, which was added by the conferees on the second deficiency bill:

"As much of this sum as is necessary shall be used to collect and disseminate such scientific, practical and statistical information as may be procured, showing or tending to show, approved methods in building, planning and construction, standardization and adaptability of structural units, including farm buildings, building materials and codes, economy in the manufacture and utilization of building materials and supplies, and such other matters as may tend to encourage, improve and cheapen construction and housing."

A special committee headed by Ira H. Woolson, of New York, already has made headway with the draft of the proposed building code. Other members of the committee are Ernest J. Russell, St. Louis; Rudolph P. Miller, New York; Joseph R. Worcester, Boston; William K. Hatt, Lafayette, Ind.; Edwin H. Brown, Minneapolis, and J. A. Newlin, Madison, Wis.

Engineering Educators Meet at New Haven

Prof. Burr Advocates Liberal Education as Basis for Engineering Study—Declares Society Neglects Fundamentals

A paper by Prof. Wm. H. Burr, formerly professor of civil engineering in Columbia University, pleading for a professional plane for engineering courses and declaring that the society was wasting its time on details and neglecting the fundamental features of engineering education, was the chief feature of the twenty-ninth annual meeting of the Society for the Promotion of Engineering Education at Yale University, New Haven, Conn., last week. The remainder of the program was of a quite formal character, only the round-table discussions on the last day affording a session above the general formal level. None of the committee reports excited special attention; in fact, the committee work was criticised by Dean A. S. Evans, of the University of Colorado, who contended that the committees were not given enough work and that their reports, when rendered, did not receive proper consideration.

The registered attendance was about 280, representing 72 institutions. The largest attendance at previous conventions was 238.

New Officers Elected

The following officers were elected for the ensuing year: President, Charles F. Scott, Yale; vice-president, H. J. Hughes, Harvard; E. J. McCaustland, U. of Missouri; secretary, F. L. Bishop, U. of Pittsburgh; treasurer, W. O. Wiley, New York City; Members of the council, P. H. Daggett, U. of North Carolina, J. K. Dunlap, U. of Iowa, M. L. Enger, U. of Illinois, J. C. L. Fish, Leland Stanford; F. E. Gieseke, U. of Texas, Morris Knowles, Pittsburgh, Pa., and O. M. Leland, U. of Minnesota.

The University of Illinois was announced as the place for the next convention.

Professor Burr's Paper

Prof. Burr's main contention was that the engineering profession could never teach the plane of law and medicine, until engineering education was put in a professional category. He explained "professional" to mean a series of technical and related courses resting on a foundation of liberal studies. Following high-school preparation a six-year course, three with a liberal arts and three with an engineering content, was advocated. The pres-

ent four-year course Prof. Burr characterized as a "college scientific course." He admitted that it had served a necessary purpose, but contended that engineering educators should be setting for themselves and their students a higher goal. On the matter of time required, he argued that engineer students could afford it just as well as law and medical students.

Prof. Burr severely criticised the Society for the Promotion of Engineering Education; saying that it had neglected a great opportunity to raise engineering education to a higher plane and that it had devoted its energies and its publication to details, rather than to a consideration of fundamentals.

Opportunity to discuss Prof. Burr's paper was not afforded, the president of the society, Dean M. E. Cooley, holding that it was best to let the significance of the paper sink in rather than indulge in adverse immediate criticism. He believed that the older men would agree with Prof. Burr.

At a later session, however, two speakers did refer to the paper, resulting in the passage of a resolution directing the officers to schedule a discussion of Prof. Burr's paper for next year's convention. It developed from the informal discussion outside the meetings that there was much agreement with Prof. Burr's main contention. There were shades of disagreement, of course, but no opportunity was afforded to ascertain the general view of the convention. An abstract of the paper will appear in next week's issue of *Engineering News-Record*.

ROUND TABLE DISCUSSION

In the round-table discussion it was brought out that a number of schools (Iowa State and Purdue being mentioned by name) are giving "problem courses" in which freshmen must solve actual engineering problems. The purpose is to give the beginners some comprehension of what an engineer actually does. At Purdue, next year, similar, but more advanced courses are to be given also to the three upper classes.

Under the topic, "Extension Work," Prof. E. D. Walker, of Pennsylvania State College, told about the expansion next fall of their extension work to include courses of collegiate grade. They are giving courses of elementary and vocational grades now to 7,000 students.

A symposium on selection and training of teachers failed to bring out any information of value.

Among the excellent papers were one by Prof. George F. Swain, of Harvard, pleading for the ideal of mental discipline rather than of culture; one by Prof. P. H. Daggett, on "Student Government at the University of North Carolina"; and one by Prof. J. W. Hallock on "Some Results of the Co-operative System," as exemplified by the experience of the University of Pittsburgh. Following Prof. Hallock's paper there was active discussion, all of it endorsing the co-operative plan. Dean Hughes stated that they were much encouraged by the first years' experience with it at Harvard.

Among miscellaneous announcements were the following: That the secretary's office would henceforth act as a clearing house for finding engineering teachers; that an association of deans and administrative officers of engineering colleges had been formed during the convention; and that the committee of institutional delegates had recommended a referendum on raising institutional dues from $10 to $25.

A committee on the licensing of engineers was created and the council was directed to arrange for carrying farther the inquiry into engineering education of which Dr. C. R. Mann's report formed an initial step.

The hospitality of Yale formed the subject of constant comment. The arrangements for the accommodation of the guests and for their entertainment left nothing to be desired. On the day following the convention the members were taken to New London on navy destroyers to inspect the submarine base and witness submarine manoevres, as guests of the Navy.

Gulf Coast Bridge Renewal Held Up

In answer to a bill of complaint filed in the U. S. District Court at New Orleans by the Louisville & Nashville R.R., in which it was alleged that the railroad commission of Louisiana had issued an order some time ago directing the company to commence construction by June 30 of steel bridges across the Chief Menteur and Bigolets passes, the court, Judge Foster presiding, on June 27 issued a temporary order to the commission and the attorney general restraining them from proceeding against the railroad company until a final hearing has been had in the matter. The company declared in its bill of complaint that the present bridges are safe for all ordinary purposes, that the authority of the commission does not extend over navigable streams, and that the commission had no legal right to order the construction of the new bridges.

Denver Commercial Association to Pick Water Consultant

A committee of five to seven Denver engineers, appointed by the Denver Civic and Commercial Association, is to recommend to the Denver Water Commission a nationally known waterworks consulting engineer. He is to study and report upon the needs of the plant and wisdom of voting funds. It is believed that such an examination would be a means of establishing confidence among the taxpayers. Because of the negative vote on a $5,000,000 bond issue recently the water problem at an early date will become acute from lack of conduit capacity. The commercial association wants early action.

Engineers to Investigate Point Bridge at Pittsburgh

A board of engineers to investigate the safety and recommend as to repair or reconstruction of the Point bridge over the Monongahela River at Pittsburgh was appointed June 23 by Director of Public Works N. F. Brown. The board consists of John D. Stevenson, assistant chief engineer, division of bridges, Department of Public Works; T. J. Wilkerson, former chief engineer of the Penn Bridge Co.; and Charles S. Davis, former chief engineer of the Massillon Bridge Co. and recentlty designing engineer for the 40th St. bridge over the Allegheny River. The bridge is forty-four years old and has a main span of the eyebar suspension type 800 ft. long, with 20-ft. roadway. It was originally designed for a maximum live load of 1,600 lb. per lineal foot, but under present street-car and truck traffic, together with increased weight due to floor reconstruction in the amount of about 300 lb. per lineal foot, is considerably overloaded. The wrought-iron eyebars are stressed to between 13,000 and 16,000 lb. per square inch instead of 12,000.

CONDITIONS DANGEROUS

Mr. Stevenson reported on the condition of the bridge Nov. 19, 1920, and again on Feb. 7, 1921, giving an urgent warning that traffic over the structure should be reduced and repairs should be undertaken at an early date. He reported that failure of 6-in. I-beams of the floor system by crushing of the web constitute a particularly serious element of the situation, that the track rails are loose, that skid chains on heavy trucks crossing the bridge at speed produce very heavy impact, and that trucks up to 13 tons weight operate over the structure; further, that street cars are not spaced as far apart as had previously been agreed upon with the street railway (150 ft.).

As a present measure of safety, upon recommendation of Mr. Stevenson and Charles M. Reppert, chief engineer, Department of Public Works, traffic regulations have been put into effect on the bridge to reduce loads and minimize vibration: Gross weight of trucks limited to five tons; street cars to be spaced at least 150 ft.; skid chains on truck tires to be limited to 1-in. projection; speed of trucks in wet weather to be limited to 6 miles per hour for trucks of four tons or more; and car stops at both ends of the bridge to be made before the cars turn the curves of the approach.

To Choose City Planning Expert

The City Planning Commission of Cincinnati, Ohio, has appointed a committee to recommend a city planning expert. The committee, which is to report by July 7, consists of Frank S. Krug, city engineer, Charles Meeds, engineer park board, Irwin Krohn, vice-president park board, and Charles S. Hornberger, director public service.

Name Engineer Staff for Staten Island Tunnel

Proposed Tubes Under New York Bay Would Carry Both Freight and Passengers

Under the general direction of Arthur S. Tuttle, chief engineer of the Board of Estimate and Apportionment of New York City, an engineering staff is being organized for the project of constructing the railroad tunnel under New York Bay between Brooklyn and Staten Island, on which work is required by statute to begin within two years from May 12, 1921. In a communication to the Mayor, acting as chairman of the Board of Estimate, dated June 28, Mr. Tuttle recommended the appointment of Col. William J. Wilgus and Frederick C. Noble as consulting engineers, at salaries of $10,000 each, and Jesse B. Snow as tunnel engineer at a yearly salary of $12,000. If these recommended appointments are concurred in Mr. Snow, who is at present serving as principal assistant to Chief Engineer C. M. Holland on the Hudson River vehicular tunnels, will assume immediate charge of the engineering work of the Staten Island tunnel project.

Among others recommended for appointment on the proposed New York Harbor tunnel are Charles B. Drew, principal assistant engineer, at $7,500; W. McK. Griffin, resident engineer, at $5,000; and Albert E. Hill, designing engineer, at $5,000.

In naming the foregoing candidates Mr. Tuttle explains that he has "given the matter of selecting a staff for carrying out this important project careful consideration to the end that the best available talent may be secured, having in view rigid requirements as to trunk line railroad experience and shield and trench tunnel experience in the Harbor of New York, as well as personal qualifications."

At a recent date the Transit Construction commissioner was authorized to contract for borings along two alternate lines across the Narrows in connection with the preliminary studies incidental to the construction of the Staten Island extension of the City's rapid transit lines. In his report to the Board of Estimate on these projects, he estimated the cost of two tunnels for passenger traffic at the southerly crossing at $20,000,000, with an additional $7,000,000 for giving one of them a sectional area large enough for freight train use.

The project which a committee headed by Mr. Tuttle has in mind would necessitate, according to its report, the use of a much flatter gradient in order to adequately handle heavy freight traffic as compared with grades which would be suitable for rapid transit use. If a satisfactory route for this tunnel was provided it should be practicable, the committee believes, to use gradients for the rapid transit line where it crosses the Narrows which would also permit of the use of one of the tubes in this section for freight traffic pending the arrival of the time when both of these services reach a magnitude such as to require separation, and to thereby very substantially decrease the amount which would otherwise have to be expended for the construction of a tunnel for freight use only.

In order that the project may be put in some definite form before further commitments are made, and assuming that the present tenants of the Stapleton piers will be given all reasonable co-operation in securing such temporary rail connections as may be desired, the committee recommends that the presidents of the B. & O., Pennsylvania, and the Long Island railroads, these representing the railroad interests most directly related to the Stapleton and Jamaica Bay developments, be requested to confer with the Commissioner of Docks and a representative of the Board of Estimate for the purpose of determining the practicability of putting into effect a definite plan whereby the rail facilities proposed by the Commissioner of Docks at Stapleton, as well as the additional facilities proposed by the committee, may be made available, and also as to the terms under which these railroads, collectively or separately as the case may be, would co-operate with the city with respect to the financing and carrying out of such a project as may seem feasible.

Atlantic and Hudson Waterways Association Meets

Fullest use of the New York State Barge Canal, as opposed to the St. Lawrence waterway project, was urged at the first convention of the Great Lakes, Hudson & Atlantic Waterways Association, held at Buffalo, June 29-30, 1921. Following addresses of Henry Moskowitz, chairman of the new association, and P. H. W. Ross, president, National Marine League, the convention was addressed by Charles L. Cadle, New York State superintendent of public works, and Frank M. Williams, state engineer. Other speakers included in the program were: S. Wallace Dempsey, chairman, Committee on Rivers and Harbors, House of Representatives; Albert E. Krell, president, Central Inland Waterways Association; S. A. Thompson, secretary, National Rivers and Harbors Congress; Murray Hulbert, commissioner of docks, city of New York; William Hill, president, New York State Waterways Association; John H. Small, president, National Rivers and Harbors Congress, and Edward S. Walsh, former superintendent of public works of the State of New York.

The view was freely expressed that freight traffic on the barge canal should be developed to the fullest extent, and that when the canal proves itself inadequate to handle business offered it would be proper only then to give serious consideration to the St. Lawrence waterways project.

Concrete Bridge Contract Illegal

Franklin County (Ohio) authorities have ordered construction work on a concrete bridge over the Scioto River at Shadesville to be stopped and new bids to be called for. The accepted bid on which work has been preceding was for $317,000, but the county prosecutor found that the procedure was irregular in a variety of ways. The commissioners continued "the making of the contract a week or more after the bids were received," bids were advertised for and received in irregular manner, certification of the necessary funds by the county auditor was not made, public inspection of the official plans was not provided for as required by state law, and the commissioners decided in advance of preparation of plans that the bridge must be of reinforced concrete.

Massive Concrete Unjustified, Says California Commission

To a published statement by the California State Automobile Association, seeking to justify its advocacy of more massive and costly concrete highway construction by reason of the presence in California of adobe and clay soils, the state highway commission has replied, pointing out that the motorists overlook the fact that while adverse frost conditions in the East are universal, adverse soils in California are found on a relatively small percentage of the total mileage. To design unduly expensive specifications for a larger part of the mileage to meet conditions on the smaller part of such mileage hardly appears to the commission like a business-like procedure.

"This is particularly so," the commission says, "when it is realized that thickness of surface slab in the East has not prevented failures there where highways have been built over adverse soils. In fact it is the failure of highways in the East, built under heavy slab specifications but where the foundation soil conditions have been unfavorable, that has turned the eyes of highway engineers away from the surface slab to the conditions that exist beneath the slab."

Answering complaints as to the width of California roads, the state highway commission asserts that the greater part of the mileage of State highways is today amply wide for the traffic it is required to serve. All paved roads are designed so that they can be widened when necessary without loss of the original investment. Certain trunk roads, it is admitted, now need widening, but the opposition of the auto clubs to the Morris bill, which proposed to make the nominal increase of $1 a year in motor vehicle fees on the average passenger car, but a very substantial increase of such fees on trucks, prevented the highway commission from getting sufficient revenue to do as much of this work as it had hoped to do.

Highway Bill Goes to Senate

(*Continued from p. 35*)

argued, nvertheless, that the latter plan would not be practicable, since to raise the necessary amount by taxation would call for such a large levy that the people would not vote the tax.

The discussion in the Senate brought out that there is considerable opposition to any change in the existing law. It was declared that the existing law had worked out fairly well and that it would be better to let well enough alone than to embark upon a revolutionary system. The question also was raised as to whether it would be constitutional for the federal government to lay out a post road and then order the state to maintain it. The federal government, it was pointed out, does not build post-offices and then attempt to order the states to keep them in repair.

Dowell Principles Discussed

The discussion of the Phipps-Dowell bill in the House developed the fact that there is an overwhelming majority in that body which is insistnt upon the Dowell principles, including compulsory maintenance. "The President has clearly indicated," said Representative Robsion, of Kentucky, "that he would not approve further appropriations for federal aid unless the state is made the unit in dealing with the federal government instead of the counties and unless the state would provide a fund for maintenance.

"The Townsend plan," continued Mr. Robsion, "contemplates just a few interstate roads. A commission in Washington lays out the system. This commission will disregard, in my judgment, the system of roads which has been laid out in each state. These systems have been partly built and contracts have been let for other portions. To cut down this system and destroy it after we have spent five years and millions of dollars in building it up would be next to a crime."

The principal obstacle to federal-aid legislation in the House has been Representative Dunn, of New York, the chairman of the committee on roads. In the course of the debate on the House bill, he said: "This is not a proper time to pass this bill. I have been against it from the start. I never thought the existing law was a square deal. The Middle states and the Eastern states pay from two to four times as much as do other states. The bill should be a 50-50 proposition, or the amount should be pro-rated according to assessed valuation instead of according to area.

"It seems singular to me that this bill should be taken up at this extra session, when we should be so busy with other matters. There still remains $150,000,000 in the hands of the Secretary of Agriculture to be met by appropriations of $200,000,000 for the separate states. In these times of financial stringency $350,000,000 is a goodly sum for this country to spend on roads during the next year or two. Under present conditions, the states have about as much as they can do to maintain the roads they already have built."

Texas is one of the seventeen states whose constitution would have to be changed to meet the provisions in the Dowell bill. Representative Rayburn, of that state, declared that the bill is most vicious. "I am getting sick and tired," he said, "of the federal government's everlastingly sticking its hands into the affairs of my state. I am against any building up of more bureaus in Washington to reach out into the states and tell the people what they shall and what they shall not do."

I. C. C. Completes Valuation Field Work in Eastern District

Engineering field work of the Eastern District, Bureau of Valuation, Interstate Commerce Commission, has been completed, including 43,000 miles of steam railroads, with a total track mileage of 82,590 mile and 50,000 miles of telegraph lines. The district comprises the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, West Virginia, Virginia, and North Carolina. With allowance for the time during which forces were not maintained during the war years of 1917 and 1918, the work was accomplished by twelve full roadway field parties in a net time of five years.

The field party work was begun on Feb. 26, 1914, and completed on June 30, 1921. The district field organization included twelve roadway parties, but this force was not maintained during the war years of 1917 and 1918, due to the fact that the Bureau released over 600 engineers for military and naval service, of which the Eastern District contributed a due proportion. The record shows that the work was in progress about seven years, but after making due allowance for vacancies which existed during the war, and the lesser number of parties in use during the organization and demobilization periods, it appears that the field party work in the Eastern District was completed in five years. This estimate is based upon an average of twelve full roadway field parties.

The field work having been completed, the Eastern District is now concentrating all of its engineering force on the preparation of the reports showing the cost of reproduction new and cost of reproduction less depreciation.

Abolish Delaware Toll Bridges

Two more bridges across the Delaware River, connecting Pennsylvania and New Jersey, were purchased by the special interstate commission charged with abolishing toll bridges across this stream at its last session. Orders were issued to the engineers of the commission to make a survey of the eleven remaining toll bridges and furnish estimates of the cost.

I. C. C. Issues More Supplemental Valuation Reports

Fifty more "supplemental" tentative valuations and twenty-five new tentative valuations have been issued by the Interstate Commerce Commission. All contain reports of present cost of condemnation and damages in excess of "present value" of lands, as required by the decision in the Kansas City Southern case, and a single figure as "final value."

The first "supplemental" reports were issued on four properties, including the Kansas City Southern, April 5, as reported in *Engineering News-Record*, April 21, 1921, p. 686. These reports cover properties for which tentative valuations already have been served and include, in addition to the original tentative reports, a statement of the original and present costs of condemnation and damages of lands in excess of "present value" and also the statement of a single sum as "final value." Most of the properties now reported upon are small, but included in the supplemental reports are the Elgin, Joliet & Eastern Ry. Co., the Norfolk Southern R.R. Co., the Georgia Southern & Florida Ry. Co.

Texas Midland Case

A supplemental report is also issued covering the Texas Midland R.R. This was the first property on which a tentative valuation was reported including a single sum as "final value." At that time, however, previous to the Supreme Court decision in the Kansas City Southern case, present cost of condemnation and damages of lands was not included. This item is now included as $268,734 and "final value" is now reported as $3,096,851. According to a previous computation of final value by Director Prouty, of the Bureau of Valuation, using his formula of value, the final figure for the Texas Midland was $3,323,038. As in the case of all of the reports now issued, no statement is included defining the method used in arriving at final figures of value.

The twenty-five tentative valuation reports now issued are the first original tentative valuations to include single sums as "final value" and a separate statement of the cost of condemnation and damages in acquiring carrier lands. While no statement is included of methods employed in arriving at the single sums named as final value, in all cases the method used to determine excess cost of acquiring land is stated as the same as used in the case of the Kansas City Southern, which was included among the four properties on which "supplemental" reports were issued April 5, 1921. Most of the twenty-five properties on which original tentative valuations are now served are small. However, the Central of Georgia Ry. Co. is included in the reports, and the "final value" of all of the property that it uses and owns for purposes of transportation is reported as $79,083,523 and owned but not used, $64,231,034.

Road Tax Receipts in Britain

The taxes collected from mechanically propelled vehicles up to May 31, to contribute toward road maintenance, are:

Vehicle	Number of Licenses	Tax Receipts
Private cars	226,000	£3,570,000
Motor cycles	370,000	760,000
Invalid vehicles	240	60
Commercial cars	120,000	2,400,000
Road locomotives	2,900	58,000
Motor plows, etc.	10,160	2,540
Motor tractors	1,400	19,000
Motor hackneys	96,500	1,530,000
Tramcars	15,200	11,400

Of the total receipts of £8,750,000, England and Wales contributed £7,922,650, Scotland £811,250, and Ireland £16,100. It was not found possible to begin collection in Ireland until toward the end of the period under review.

Engineering Societies

The Engineers' Association of Fairfield County, Conn., at its fifth annual dinner, June 2, was addressed by Nelson P. Lewis, formerly chief engineer Board of Estimate and Apportionment, New York, on "Scientific City Planning." The other speakers were F. B. Bartram, president, Stamford (Conn.) Chamber of Commerce, on "Stamford's Future Possibilities in Industries," and Rev. A. G. Walton on "Engineers as Influential Citizens."

Personal Notes

L. K. SHERMAN, vice-president of the Edmund T. Perkins Engineering Co. prior to the death of Edmund T. Perkins who was president of the company, has been made its chief enginer.

JOHN J. SWAN, formerly with the Prest-O-Lite Co., Indianapolis, Ind., has become associated with the Engineering Business Exchange, New York. He was graduated from Cornell in 1897 and was, for a time, associate editor of *Engineering News*. He later held executive positions with industrial companies among which were the Ingersoll-Rand Co., the Longmead Iron Co., the Chicago Pneumatic Tool Co., Keller Mfg. Co., and the American Arms Corp. During the war he was a member of the committee in the adjutant-general's office in charge of the classification of the personnel of the army and was commissioned a lieutenant-colonel.

EUGENE E. HASKELL has retired as dean of civil engineering, Cornell University. Dean Haskell is a graduate of Cornell University, C. E. in 1879 and M.C.E. in 1890, and was at the head of the college of civil engineering since 1906. Prior to this date he was in government service in the Mississippi River Commission work and in the U. S. Coast and Geodetic Survey, during which time he invented the Haskell current meter. From 1893 to 1906 he was engaged in reorganizing and directing the U. S. Hydrographic Survey of the Great Lakes Basin. During his connection with Cornell he was appointed by President Roosevelt as one of the three members of the American Section of the International Water Ways Commission. In 1915 he was appointed by the Dominion of Canada as one of the engineers of the Montreal Water Levels Commission. He is also a member of the board of consulting engineers of the New York State Barge Canal. Dean Haskell, during his sabbatic leave this year, was succeeded by Prof. Fred A. Barnes, C.E., M.C.E., Cornell, '97.

ALBERT J. MANTICA, formerly designing engineer with the Compania General de Construcoes, Lisbon, Portugal, agents of the Truscon Steel Co., Youngstown, Ohio, is now sales engineer with the Truscon Steel Co.

ERWIN DAMES, with Benham & Mullergren, consulting engineers, Kansas City, Mo., has been made resident engineer for the firm at Duncan, Okla., where pavement and water-works improvements costing about $1,000,000 will be installed.

M. C. WELBORN, division engineer with the Texas State Highway Department, has resigned to become city engineer of Paris, Tex.

P. S. GARDINER, Eastmen-Gardiner & Co., Laurel, Miss., who has been vice-president of the Southern Pine Association, New Orleans, for five years, has been elected president, succeeding A. L. Clark, Dallas, Tex., resigned. Mr. Clark continues as director representing Florida.

W. J. KING of Oswego, Kan., has resigned as county engineer, Labette County and has taken a position as engineer for M. E. Gillioz, Monett, Mo.

ARTHUR J. TURNER, for the past two years chief engineer for the Columbia Basin survey commission of the State of Washington, resigned that office June 1 to become superintendent of construction on the Skagit River power project being carried out by the City of Seattle. C. F. Uhden, chief engineer of the Skagit project, and Mr. Turner held the same relative positions for the Washington Water Power Co. during the construction of the Long Lake dam and power plant and they have gathered together on the Skagit project a considerable number of the same staff that worked together at Long Lake.

IVAN E. GOODNER succeeds A. J. Turner as chief engineer of the Columbia Basin project. Mr. Goodner has been office engineer for the Columbia Basin Commission since its organization.

ALMIRALL & CO., INC., constructing engineers, announce that E. W. Verity, Jr., has been appointed construction manager with headquarters at New York, and that Carl H. Sanborn has been appointed New England representative with headquarters at Boston, Mass.

C. E. DAVIES has been appointed managing editor of the American Society of Mechanical Engineers' publication *Mechanical Engineering* to succeed the late L. G. French. He was graduated from Rensselaer Polytechnic Institute with the degree of M.E. and then, for several years, specialized in industrial management work. He has been an associate editor on the society's journal since March, 1920.

Obituary

JOHN F. WALLACE, consulting engineer, New York, past-president of the American Society of Civil Engineers, chairman of the Chicago Railway Terminal Commission, chairman of the board, Westinghouse, Church, Kerr & Co., New York, and formerly chief engineer of the Panama Canal Commission, died in Washington, D. C., July 3. Next week's issue will contain a more extended statement of Mr. Wallace's activities in the engineering fiield.

S. T. MORSE, consulting engineer, and formerly city engineer of Carlinville, Ill., was killed in an automobile accident on June 3.

DANIEL W. MAHER, engineer and contractor, secretary of the Marquette Construction Co., Chicago, died June 20.

Business Notes

THE BROWN HOISTING MACHINERY CO., Cleveland, Ohio, has opened an office in New Orleans, La., with Charles H. White as manager.

LESLIE H. ALLEN, formerly with Fred T. Ley & Co., contractors, Springfield, Mass., as sales manager of the New England territory, has been appointed assistant manager of the Cement Products Bureau of the Portland Cement Association.

THE LINK-BELT CO., Chicago, Ill., has acquired all of the capital stock of the H. W. Caldwell & Son Co.; Frank C. Caldwell has been elected a director of the Link-Belt Co.

A. E. SCHRODER has been appointed branch manager of the Toledo, Ohio, office of the Truscon Steel Co., to succeed B. E. Bowlus, who has been made a special representative of the cash sales department at the Youngstown, Ohio, office.

JOHN A. CONBOY CO., a new sales organization handling contractor's railroad, mine and industrial machinery and equipment, have opened offices in Philadelphia, Pa.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Civil Suit Filed Against Cement Manufacturers Association

A complaint in equity has been filed in the Federal Court for the Southern District of New York by Col. William Hayward, United States Attorney, asking for the dissolution of the Cement Manufacturers Protective Association, the nineteen members of which in the Northeast are said to manufacture approximately 90 per cent of the cement produced in this territory. The civil suit supplements criminal indictments returned March 1 charging violation of the Sherman Anti-Trust Law against 116 cement manufacturer defendants. The criminal indictment was an outgrowth of the investigations made by the Lockwood joint legislative committee on housing.

In addition to the nineteen firms, four individuals who are officers of the Cement Manufacturers Protective Association are named in the civil suit. The defendant officers are E. T. Alker, president; C. Raymond Hulsart, vice-president; Miss M. B. Phalen, secretary, and Marion S. Ackerman, treasurer.

The civil suit is the first brought in the name of Attorney-General Daugherty to test the legality of the open-price associations whose members are alleged by the government to fix future prices unlawfully under the guise of discussing current prices, the latter being permitted by law.

The government, in the complaint, prays the court perpetually to enjoin the defendants from continuing the alleged combination and conspiracy. The defendants are given twenty days from date of service of the complaint in which to file an answer.

The cement manufacturers named in the complaint are the Atlas, Allentown, Alpha, Bath, Copley, Dexter, Edison, Giant, Glenns Falls, Hercules, Knickerbocker, Lawrence, Lehigh, Nazareth, Penn-Allen, Pennsylvania, Phoenix, Vulcanite, and the Security Cement & Lime Co.

The Cement Manufacturers Protective Association is an unincorporated body which was organized at the Engineers Club in New York City, Jan. 6, 1916.

Lumber From Northwest Going to Atlantic Coast

During the first quarter of 1921, 42,500,000 ft. b.m. of lumber was shipped from the Pacific Northwest to the Atlantic Coast, as against 1,200,000 ft. b.m. for the corresponding quarter of 1920. Shipments to Europe dropped from 24,000,000 ft. b.m. to 16,300,000 ft. b.m. The east coast of South America got 600,000 ft. b.m. in 1921 and none in 1920. The figures were compiled by the Pacific Lumber Inspection Bureau at Seattle.

Contracts Let for First Six Months of 1921 Have Total Value of $579,249,777

This Year's Contracts Exceed Those of 1920 in Street and Road, and Public Works Construction

The total value of all contracts let during the first six months of 1921, as reported in *Engineering News-Record*, is $579,249,777. No residential building is included in these figures, nor housing, except that classified as industrial, and apartments. Although this figure represents but 60 per cent of the total value of contracts let during the corresponding period of 1920, 1921 has exceeded 1920 in public works construction and street and highway building. One of the most remarkable facts to be noted in connection with an analysis of contracts let is the tremendous activity in street and highway work for the first six months of 1921. The total value of contracts let in this class of construction is in excess of $172,000,000, or $18,000,000 more than for the corresponding period of 1920. In comparing these figures—those of 1920 and those of 1921—no account is taken of the decreased cost of construction that has occurred within the past year owing to a decline in material and other costs. Were that differential applied, the total value of the 1921 contracts would be in the neighborhood of $700,000,000.

Another notable feature of the accompanying tables is the fact that during June, 1921, the total value of contracts let exceeded the value of contracts let in June, 1920, by about $26,000,000, the respective figures being 1921, $140,578,814, and 1920, $114,710,161.

It may also be noted that, excluding industrial construction from the total figures for the two years, the 1921 contract value is approximately 80 per cent of the 1920 contract value, again taking no account of the decreased cost of construction which if included would put the contract values of the two years approximately on a parity.

In public works constructon the value of contracts let during 1921 is more than 40 per cent in excess of the value of 1920 contracts, the respective figures being: 1921, $33,500,000; and 1920, $23,000,000.

Attention is also called to the steadiness of the contract values for the months of 1921 as compared to 1920. It is seen that June, 1921, returned the greatest contract value of the six months' period, whereas during 1920 April was the big month, with June the smallest.

The greatest disparity in the two years in the value of contracts let is seen to be in industrial work. So far this year industrial work has been extremely quiet, the total value of contracts being approximately $56,000,000 as compared to $314,000,000 during 1920.

Due to the fact that *Engineering News-Record* is receiving news daily of many projects which are either in the proposed stage or upon which bids will soon be received, it is quite likely that both public works construction and street and road work will continue very active in the coming months.

CONTRACTS LET FOR FIRST SIX MONTHS OF 1920

	January	February	March	April	May	June	Total
Waterworks	1,143,777	2,171,725	2,213,262	2,719,021	1,381,655	1,460,501	11,089,941
Sewers	1,863,840	622,874	1,283,227	4,123,907	2,314,874	2,348,517	12,557,239
Bridges	2,021,553	2,137,393	2,238,661	5,586,877	5,363,709	3,185,682	20,533,875
Streets—roads	12,203,970	21,334,013	26,220,967	33,340,330	30,257,872	31,441,154	154,798,306
Excavation	1,541,576	786,943	3,151,151	415,512	403,705	604,585	6,903,472
Industrial	56,041,047	63,262,290	48,861,832	65,879,005	39,661,869	40,453,500	314,159,543
Buildings	87,095,987	52,200,466	47,541,078	90,776,835	70,946,738	31,271,042	379,832,146
Federal Gov't	4,980,945	2,282,373	1,483,605	4,124,269	1,167,045	2,625,739	16,663,976
Miscellaneous	8,256,071	3,466,519	15,129,378	9,602,630	14,373,320	1,319,441	52,147,359
Totals	175,148,766	148,264,596	148,123,161	216,568,386	165,870,787	114,710,161	968,685,857

CONTRACTS LET FOR FIRST SIX MONTHS OF 1921

	January	February	March	April	May	June	Total
Waterworks	519,028	2,927,307	2,028,055	3,342,150	4,943,562	3,494,584	15,254,686
Sewers	3,146,948	2,445,075	2,862,131	3,817,401	2,162,460	3,802,040	18,236,055
Bridges	3,030,477	885,529	1,443,060	1,987,808	1,642,894	2,417,632	11,407,400
Streets—roads	11,597,810	12,049,344	25,880,109	31,026,312	35,064,031	56,772,257	172,389,863
Excavation	1,266,346	305,740	1,625,690	580,039	2,631,799	1,240,398	7,650,012
Industrial	12,881,968	4,737,850	15,032,130	9,346,586	7,799,584	6,111,307	55,909,425
Buildings	17,455,673	31,902,608	56,520,231	51,647,900	48,442,471	56,576,768	262,545,651
Fed. Govt.	2,071,141	1,574,927	3,590,617	1,186,403	1,809,588	4,158,430	14,391,106
Miscellaneous	2,358,976	1,728,441	4,231,823	2,732,799	4,408,142	6,005,398	21,465,579
Totals	54,328,367	56,556,821	113,213,846	105,667,398	108,904,531	140,578,814	579,249,777

West Coast Lumber Production

For the week ended June 18, 113 mills in western Oregon and western Washington reported a production to the West Coast Lumbermen's Association of 59,000,000 ft.bm., which is 29 per cent below normal. New business totaled 63,000,000 ft.bm. and shipments 60,000,000 ft.bm. In the cargo trade domestic orders totaled 5,000,000 ft.bm. and export shipments 7,000,000 ft.bm.

Number Idle Freight Cars Declines

The number of surplus or idle freight cars on the railroads of the country continue to decline according to reports just received from the carriers by the car service division of the American Railway Association. These show that on June 23 there were 377,850 cars in excess of current freight requirements or a reduction of 3,896 cars compared with the total on June 15.

Surplus box cars totaled 140,627 or a decrease of 3,308 in approximately a week while surplus coal cars numbered 163,982. The latter figure is an increase of approximately 4,500 over that already reported for June 15 but this is due principally to a correction that had to be made in the earlier figures resulting from a mistake made by one of the large carriers in its report.

Reports also showed an increased demand for other classes of freight cars. From June 15 to June 23, surplus automobile and furniture cars declined approximately 460, flat cars 388 and stock cars 1,140.

Average Price of Brick Declines $1 During May

As an indication of the price trend, the average price of brick per thousand fell from $16.11 for the May 1 price to $15.14 for that of June 1, says the June digest of the Common Brick Manufacturers Association. This composite price is not the actual price in any market, but is the average taken from the reports of 97 plants. There were fewer plants closed by sixteen than were closed when the previous month's report was compiled. The lowest plant price quoted in the June digest is $10 per thousand for the Southeastern states.

Pennsylvania Months Ahead of 1920 in Road Building

The Pennsylvania State Highway Department so far in 1921 has finished forty-six road construction projects, involving a total of 169 miles. Up until June 28, the department in 1921 had completed 207 miles of durable thoroughfare, a total not reached in 1920 until mid-September.

House Fixes Duty on Cement and Structural Steel

Portland, Roman and other hydraulic cement is made dutiable at 5c. per 100 lb., in the tariff bill reported June 30 by the committee on ways and means of the House of Representatives. That rate of duty is to apply when the cement is in barrels, sacks or other packages and the weight of the container is to be included in the weight on which the duty is assessed. When the cement is in bulk, the rate of duty recommended is 4c. per 100 lb. Other types of cement are to be dutiable at 17 per cent ad valorem.

Freestone, granite, sandstone, limestone, lava and all other stone suitable for monumental or building purposes are made dutiable in the bill at 40 per cent ad valorem. When such stone is not dressed, hewn or polished, the duty recommended is 15c. per cubic foot.

The paragraph in the bill applying to structural iron and steel reads as follows:

"Beams, girders, joists, angles, channels, cartruck channels, tees, col-

Labor Rates and Conditions Throughout the Country

THE PRINCIPAL varified adjustments in labor rates shown in the regular monthly tabulation on this page are for Pittsburgh, Minneapolis, Seattle and Kansas City. Labor is plentiful in Minneapolis, but, although $1 per hour is the rate for bricklayers as set May 1 by the employers, $1.12½ is being paid rather generally. On the other hand, although the rate for carpenters in this city is 80c., they are reported to be working for as low as 70c. to 75c. The standard rate for common labor is 50c., but this is not constant, wages going as low as 40c. an hour in some cases. In the July 1 schedule just issued by the building trades of Pittsburgh, bricklayers are listed at $1.12½ as against $1.50, the old rate. Carpenters, structural iron-workers and hoisting engineers are rated at $1, whereas the former rates were $1.25 for carpenters, $1.12½ for hoisting engineers and $1.25 for iron-workers. The former rate for laborers was 80c., whereas now no rate is given, indicating that the market is open. Denver reports that carpenters and painters have accepted the Industrial Commission wage award of $1 per hour, thus ending a controversy that has lasted several months. On the whole, conditions show a decided improvement in Denver. The Seattle rates are those paid by the Master Builders' Association, which handles nearly all construction in Seattle and the Puget Sound district. The association employs only non-union men, and the union scale is approximately 10 per cent higher than the figures shown. All classes of labor are plentiful in this city. For Kansas City we show the rate for bricklayers and structural iron-workers $1.07½ per hour, as against $1.12½ and $1.10 respectively. The present rate for hod-carriers is 80c., against 90c. previously. Common labor is 70c., as against 75c.

S means scarce; E, enough; P, plentiful—Higher rates indicated by +, decreases by—

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90P	$0.70P	$1.00P	$0.30P	.....	$1.00P	$0.25P
Baltimore	1.25P	.80P	.87½P	.54P	$0.74P	1.00P	.35P
Birmingham	1.00	.87½	.....	.25@.40	.....	1.00	.20@.25
Boston	.90	.90P	.90P	.60P	.90P	.90P	.55P
Cincinnati	1.25P	1.00P	.70E	.85P	1.00E	1.25P	.35@.40
Chicago	1.25	1.25	.....	.....	.....	1.25	1.00
Cleveland	1.25P	1.25P	1.25P	.87½P	1.10P	1.25P	.87½P
Dallas	1.00P	1.00P	1.00E	.60E	1.00E	1.00E	.50@75P
Denver	1.37½	1.00	1.00	.75@.81¼	1.00	1.00	.37½@50
Detroit	1.00P	.80P	.80@.90P	.50@.60P	1.00P	.60@.80P	.50P
Kansas City	—1.07½	1.00	1.00	—.80	—1.07½	1.07½	—.70
Los Angeles	1.25P	1.00P	1.00P	1.12½P	1.00P	1.00P	.75P
Minneapolis	1.00P	.80P	.80P	.65P	.....	.80P	.50P
Montreal	.90P	.65P	.60P	.35P	.....	.65P	.30P
New Orleans	1.00P	—.88P	—.85P	—.40P	1.00P	1.00P	—.30P
New York	1.25	1.12½	1.25	.87½	1.12½	1.12½	.75@.80
Pittsburgh	—1.12½P	1.00P	—1.00P	—.80P	.....	—1.00P	Open
St. Louis	1.25P	1.25P	1.25P	.85P	1.25P	1.25P	.67½P
San Francisco	1.25P	1.12½P	1.12½P	1.00P	1.12½P	1.12½P	.81¼P
Seattle	1.00P	.80P	.80P	.70P	1.00P	.87½P	.50P

umns and posts, or parts or sections of columns and posts, deck and bulb beams, and building forms, together with all other structural shapes of iron or steel, not assembled, manufactured, or advanced beyond hammering, rolling, or casting, seven-twentieths of 1c. per pound; any of the foregoing if machined, drilled, punched, assembled, fitted, fabricated for use, or otherwise advanced beyond hammering, rolling, or casting, 25 per centum ad valorem."

Bethlehem Reduces Steel Prices

The Bethlehem Steel Co., which recently announced a 15 per cent reduction in wages for July 16, has now reduced its schedule of prices, as follows: Bars, from $2.10 to $1.90; structural shapes and plates, from $2.20 to $2; sheet bar, from $39 to $35; billets, 4 x 4, from $37 to $33; slabs, from $38 to $34; blue annealed sheets, from $2.85 to $2.65; black sheets, from $3.75 to $3.50; galvanized sheets, from $4.75 to $4.50; tin plate, from $6.25 to $5.75; skelp, from $2.20 to $2. This is a reduction of $4 per ton on bars, structural shapes, plates, skelp, billets, sheet bar, slabs and blue annealed sheets, and a $5 per ton reduction on black and galvanized sheets.

In making the announcement, E. G. Grace, president of the company, states: "Present manufacturing costs do not in any sense warrant these reductions, but this company desires to contribute even more than its full share to re-establish conditions in the steel trade on what might be regarded as a normal basis. The increase in freight rates has been the largest factor in increasing the cost of manufacturing steel products, because making a ton of finished steel involves transportation of more than five tons of raw materials. The cost factors next in importance are materials and labor."

Unemployment in New York Decreases

The ratio of workers seeking employment to each 100 places open was 135 in April, according to the tabulation of the April reports from the offices of the New York State Employment Bureau. The ratios for recent months were 145 for March, 169 for February, and 169 for January. These ratios indicate January and February as the months of greatest unemployment, and that unemployment decreased materially from these months to the end of April. The reduction in unemployment was due to the usual seasonal activities.

A New Road Blade-Grader

The Avery Co., Peoria, Ill., has recently put upon the market a one-man road maintainer in the form of a tractor-operated blade-grader, as shown in the accompanying photograph. The operator, sitting at the rear of the tractor, with the blade in front of and

NEW ONE-MAN ROAD GRADER

below him, can see the work done by the machine. The blade attachment, 12 ft. long, consists of three sections and is adjustable both to the curvature of the road and the depths of cut. The tractor is equipped with a six-cylinder motor and three-speed transmission.

Southern Pine Shipments and Demand Exceed Production

May shipments of Southern pine were 108 per cent of production, and May demand 101 per cent of production, says the monthly trade barometer of the Southern Pine Association. The production for the month was 80 per cent of normal with 191 subscribers' mills reporting. Orders for the month of May were—137 mills reporting—84 per cent of normal, and shipments for the month were 86½ per cent of normal. The stocks on hand as of May 1 amounted to 1,260,900,005 ft.bm. The May cut was 389,744,552 ft.bm., and the May shipments, 420,662,930 ft.bm., with 191 subscriber mills reporting. The stocks on hand May 31 were 1,229,981,627 ft.bm.

Building in New York City

The estimated cost of building operations authorized in the ten chief cities of New York State increased from $32,235,467 in March to $34,900,309 in April, a gain of 8 per cent, says the *Labor Market Bulletin*, published by the bureau of statistics and information of the New York State Industrial Commission. The April amount, however, was 26 per cent below that reported in the same month a year ago. The total estimated value of building work authorized in the period from January to April of 1921 was $106,259,094 compared with $136,291,432—28 per cent more—reported in the first four months in 1920.

The gain in building activity in April, contrary to the tendency of the preceding three months, was mostly in up-state cities. Every up-state city showed an increase in the estimated value of prospective building work, the increase ranging from 8 per cent in Rochester to 99 per cent in Troy. The New York City gain was 5 per cent.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Owing to slackness of the market, prices are useful only as a guide. They are generally lower than a month ago, and sales have been made on small lots at even lower prices than we quote. For example, although our price is $24.96 per ton for No. 2 foundry, Valley furnace, it is reported that small sales have been made at $21.

Railway Materials—No change in price of standard rails and although new light rails are held at $2.10 per 100 lb., light rails rolled from old rails have been available at $1.80. Track supplies are weaker, standard spikes being obtainable at as low as $3.25 per 100 lb., and track bolts at $4. Cross-ties are the same price in St. Louis, but are down 10c. per tie in Chicago.

Pipe—No changes on steel pipe. Cast-iron pipe down in New York, Birmingham, Chicago, St. Louis, and San Francisco. Sewer pipe down in St. Louis.

Road Materials—Very few changes since last month. Asphalt slightly cheaper in Atlanta and down $5 per ton in Cincinnati. Paving stone is being shaded slightly in Cincinnati. Wood blocks were not quoted in Minneapolis last month but the latest sale to the city was at $2.37 per sq.yd.

Sand, Gravel and Crushed Stone—Sand and gravel down in Cincinnati, Atlanta and Detroit, and sand down 30c. in New Orleans. Crushed stone down 25c. in Atlanta.

Lime—Hydrated down in Cincinnati and Atlanta, while lump is reported to have advanced slightly in those cities.

Cement—Nothing to report.

Common Brick and Hollow Tile—Market slightly firmer in New York, although delivered price remains the same. Price slightly weaker in Minneapolis and down in Boston, Dallas, Kansas City, Seattle, Detroit and Atlanta. Hollow tile down in New York and Chicago, Seattle.

Roofing Materials—Prepared roofings are down 8 to 25c. Asphalt felt and tar pitch are also cheaper.

Steel—The price reductions announced by the Bethlehem Steel Co., effective July 5, are given in detail elsewhere in this section. The United States Steel Corporation advises of no revision of their schedule at present. Dealers had decreased warehouse prices a week ago.

Lumber—The base wholesale price of Southern pine in New York is now $42 per 1,000 ft., b.m., the carload price to contractors being about $5 higher. Fir and hemlock down in Boston; fir down in Denver and Seattle. General reduction in Minneapolis

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	*$25.80*	$45.80
Northern Basic	*25.50*	42.60
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	*25.52*	46.80
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	*32.26*	49.70
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	*22.00*	42.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@ 2.75 sil.)	*26.26*	46.00*
Virginia No. 2 (silicon 2.25 @ 2.75)	*27.00**	45.00*
Basic	*25.00†*	44.50†
Grey Forge	*24.40*	43.50*
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	*22.00*	43.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	*28.67*	47.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	*24.96*	45.65
Basic	*23.46*	44.40
Bessemer	*24.96*	44.90

*F.o.b. furnace. † Delivered.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	$45.00	$45.00 @60.00		$45.00
Standard openhearth rails	47.00	47.00 @60.00	$47.50	47.00
Light rails, 8 to 10 lb.	*2.20*@2.30*	2.58½@ 3.75		2.45@3.00*
Light rails, 12 to 14 lb.	*2.15*@2.25*	2.54*@ 3.75	2.20*	2.41@2.95*
Light rails, 25 to 45 lb.	*2.10*@2.20*	2.45*@ 3.75	2.20*	2.32@2.85*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8 Ft. 6 In.
Chicago, White Oak	*$1.85*@$1.40*	*$1.45*@$1.50*
Chicago, Hardwood and Red Oak	*1.25*@ 1.30*	*1.40*@ 1.45*
Chicago....Empty Cell Creosoting (add'l)	45	.50
San Francisco..... Green Douglas Fir	.80	1.12
San Francisco, Empty Cell Creosoted, Douglas Fir	1.76	2.48

For ties on standard "railroad administration" specifications, f.o.b. cars, St. Louis:

	White Oak	Red Oak	Pine and Cap Cypress
Grade 3	$1.35	$1.20	$1.10
Grade 2	1.25	1.10	1.00
Grade 1	1.15	1.00	.90

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco
Standard spikes, ½-in. and larger	*$3.25*@$3.40*	$4.00	$3.40	$4.52½	*$5.70*
Track bolts	*4.00*@ 4.35*	6.00@6.50	4.60	5.60	*6.65*
Standard section angle bars	2.50	3.00@4.00	2.75	3.25	4.50

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card of April 13, 1921:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62½	50	¼	33½	18½
			⅜ to 1½	35½	20½

LAP WELD

2	54½	58½	1½	42½	...
2½ to 6	58½	46	2	30½	16½
7 to 12	54½	41	2½ to 6	33½	20½
13 and 14	45	...	7 to 12	29½	16½

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60½	49	1 to 1½	35½	21½
2 to 3	61½	50			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	52½	41	2	31½	18½
2½ to 4	56½	45	2½ to 4	34½	22½
4½ to 6	55½	44	4½ to 6	33½	21½
7 to 8	50½	37	7 to 8	24½	12½
9 to 12	45½	32	9 to 12	19½	7½

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	54%	62½%	50½%
3½ to 6 in. lap welded	49%	58½%	46½%

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	40%	50%	36½%
3½ to 6 in. lap welded	35%	46%	32½%

Malleable fittings, Class B and C, from New York stock sell at net list prices Cast iron, standard sizes, 20—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York Current	New York One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
4 in.	*$53.30*	$79.30	*$50.00*	*$57.10*	*$45.00*	*$85.00*
6 in. and over	*48.30*	76.30	*45.00*	*54.10*	*45.00*	*80.00*

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

Size, In.	New York Current	New York One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$50.00	$35.00	$60.00	$50.00		$55.00
4	60.00	51.00	60.00	60.00	$90.00	65.00
5	90.00	65.00	85.00	80.00	115.00	84.00
6	115.00	90.00	85.00	100.00	150.00	110.00
8	185.00	130.00	100.00	150.00	250.00	181.00

SEWER PIPE—The following prices are in cents per foot for carload lots:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.22	$0.132		*.120*	$0.135	$0.13	
4	.22	.132	$0.11	*.120*	.135	.1625	$0.18
5	.34	.198		*.168*	.2025	.195	.165
6	.34	.198	$.165	*.168*	.2025	.2275	.25
8	.52	.308	.275	*.240*	.315	.325	.35
10	.78	.462	.355	*.336*	.4725	.455	.....
12	1.00	.594	.4675	*.432*	.6075	.585	.80
15	1.50	.792	.6875	*.650*	.81	.975	.....
18	2.18	1.10	.935	*.850*	1.125	1.365	.....
20	2.60	1.32	1.2375	*1.15*	1.35	.....	.....
22	3.50	1.98	.....	.....	1.80	.....	.....
24	3.90	.....	1.7875	*1.50*	2.025	2.34	2.40
27	.....	.....	.....	*2.55*	3.75	3.25	.....
30	.....	.....	4.00	*3.10*	4.75	3.90	.....
33	.....	.....	.....	*3.85*	5.50	.....	.....
36	.....	.....	.....	*4.20*	6.00	.....	.....

	3	5	8	12	24	36
Boston	$0.138	$0.207	$0.322	$0.621	$2.07	$5.433
Minneapolis	.....	.....	.42	.77	2.45	5.66
Denver	.....	.15	.30	.50	1.95	.....
Seattle	.145	.....	*.36*	.72	*2.59*	.....
Los Angeles	.11*	.165*	.275	.465	1.65	.....
New Orleans	.....	.1102	.27	*.46*	*1.76*	.....
Cincinnati	.126	.189	.294	.567	1.89	5.0225
Atlanta	.11*	.165*	.27	.4675	1.7875	.....
Montreal, *delivered*	.30*	.45*	.85*	1.35	4.50	6.50
Detroit	**.123**	**.1845**	**.287**	**.5535**	**2.34**	**5.8425**
Baltimore	.13	.198	.31	.595	2.00	.....
Baltimore, *delivered*	.....	.28	.44	.86	2.84	.....

*4-in., 6-in., 9-in., 30-in. respectively.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

	Current	One Year Ago
New York, 45% asphalt.... (at terminal)	$0.06½	$0.13
New York, 65% asphalt.....(at terminal)	.06	.13
New York, binder.....(at terminal)	.07	.13½
New York, flux.....(at terminal)	.06½	.14
New York, liquid asphalt....(atterminal)	.08	.10
St. Louis, 40-60% asphalt (*f.o.b.*) *Tulsa, Okla.*	*.02½**	.....
Chicago, 40-50% asphalt	.06	.08
Chicago, 60-70% asphalt	.06½	.08½
Dallas, 40-50% asphalt	.10	.07
Dallas, 60-70% asphalt	.13	.08
Dallas, 75-90% asphalt	.15	.10
San Francisco, binder, per ton	15.00	2.25

* Freight $21.75 per ton to Whiting, Ind.

ASPHALT—Price per ton in packages (350-lb. bbl., or 425-lb. drums, and in bulk in carload lots:

	Package	Bulk
New York (Bayonne, N. J.)	$28.00	$16.00
Boston	No quotations	
Chicago	28.50	21.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	21.50*	15.00*
Dallas	35.00	27.00
Seattle	27.50	...
Denver	...	50@70
Minneapolis	...	25.93
St. Louis	sold out for 1921	
Baltimore	40.00	...
Los Angeles, *at factory*	22.50	15.00
Montreal	28.00	21.00
Atlanta	32.50	...
Detroit (petroleum asphalt)	24.50	20.00
Cincinnati	*32.50*	*26.50*
Maurer, N. J. (asphalt)	27@38	...
Maurer, N. J. (asphalt cement)	29@36	25@31

*Freight to San Francisco, 80c. per ton.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York	5-in. granite	No quotations
Chicago	About 4x8x4 dressed	$3.35 sq.yd.
	About 4x8x4 common	3.00 sq.yd.
San Francisco	Basalt block 4x7x8	65.00 per M
Boston	5-in. granite	4.20 sq.yd.
Atlanta	Granite	2.00 sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	107.00 per M
Baltimore	Granite	2.25 sq.yd.
Montreal	Granite	130.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 sq.yd.
Cincinnati	Granite	4.25 sq.yd.
St. Louis	4x8x4 dressed	3.40 sq.yd.
	4x84x common	3.00 sq.yd.
Kansas City	No. 1 Granite	3.90@3.95 sq.yd.

FLAGGING—

New York	Bronx	$0.25	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	1.00	lin.ft.
Chicago	18 in. wide	.70	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 70c. for 5x16 in., 80c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	*$2.27*
New York	3½	16	*2.49*
New York	4	16	*2.75*
Boston	5	16	3.45
Chicago	4	16	3.75@4.00
Chicago	3½	16	3.25@3.50
St. Louis	3½	16	3.05
St. Louis	4	16	3.50
Seattle	4	16	Off market
Minneapolis	3½	16	2.37
Atlanta	3½	16	2.30
New Orleans	3	16	2.99
New Orleans	3½	16	3.42
New Orleans	4	16	3.85
Dallas	4	18	3.90
Baltimore	3½	16	3.75
Montreal, *delivered*	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	3.30
Kansas City	4	16	*2.35*

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots is as follows, per cu.yd.:

	Gravel — 1½ In.		Gravel — ¾ In.		Sand	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
New York	$2.50	$3.00	$2.50	$3.00	$1.25	$1.50
Denver	2.00	1.80	1.80	1.80	1.60	1.40
Chicago	2.25	2.15	2.25	2.15	2.25	2.15
St. Louis, *per ton*	1.55	1.78	1.60	1.82	1.60*	1.68
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas, *delivered*	3.50	2.50	4.00	2.50	3.00	2.00
Minneapolis, *at pit*	2.00	1.50	....	1.35	1.00	.75
Cincinnati	*2.25*	....	*2.30*	1.55	*1.65*	1.50
San Francisco	2.25	2.50	**2.50**	2.50	1.50	1.65
Boston, per ton	2.65	3.00	2.65	3.00	2.00	3.00
New Orleans	2.85	3.00	....	....	*1.35*	1.40
Los Angeles, per ton	1.45†	1.25	1.45†	1.25	1.30†	1.15
Atlanta, per ton	*2.35*	2.25	....	2.25	*1.40*	1.15
Detroit	*2.25*	2.50	*2.25*	2.00	*2.25*	1.85
Baltimore, per ton	1.40	1.40	1.60	1.60	.70	.80
Montreal, per ton	1.50	1.25	*1.50*	....	1.25	1.40
Birmingham	....	3.25	....	3.75	1.43	1.25

* Fine white sand: Pacific, $5 per ton; Ottawa, $6.
† Freight from quarry to Los Angeles is 80c. per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless otherwise, is as follows, per cu.yd.:

	1½ In. — Current	1½ In. — One Year Ago	¾ In. — Current	¾ In. — One Year Ago
New York	$1.90@2.00	$1.90	$2.15	$2.15
Chicago	2.50	2.15	2.50	2.15
St. Louis *delivered*	2.60*	1.90	2.60*	1.90
Dallas	2.80	3.50	2.80	3.50
San Francisco	2.25	2.50	**2.50**	2.75
Boston, *delivered*	3.00*	3.00	3.00*	3.00
Minneapolis, *at plant*	2.00	1.50	2.25	1.60
Kansas City†	1.25	2.35	1.40	2.35
Denver	....	3.75	....	3.75
Seattle *delivered*	3.50	3.50	3.50	3.50
Atlanta	*2.25**	3.10	....	....
Cincinnati *delivered*	3.24	....	3.24	1.65
Los Angeles	*1.50**	1.60	1.80*	1.70
Detroit	2.00*	1.75	2.00*	1.75
Baltimore	1.75*	1.60	1.75*	2.00
Montreal	2.00*	1.75	2.10*	2.00
Seattle, *delivered*	3.00	....	3.00	....

*Per ton. †F.o.b. Joplin, Mo.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Lebanon or Bethlehem, Pa.	$1.00	$1.00	$2.50	$0.90
Easton or Catasaqua, Pa.	1.00	1.00	2.00	.90
Buffalo, N. Y. and Erie, Pa.	1.25	1.25	2.25	1.25
Emporium, Pa.	1.25	1.25	....	1.25
East Canaan, Conn.	1.25	1.35	4.00	1.10
Birmingham, Ala.	1.25	1.25	2.05	1.00
Toledo, Ohio	1.50	1.50	2.35	....
Atlanta, Ga.	....	*2.10*	....	....
Eastern Pennsylvania and New Jersey	1.20	1.20	2.50	.90
Westrn Pennsylvania and New Jersey	1.25	1.25	2.50	1.25

Birmingham, f.o.b. pit $1.15 (or $2.75 per cu. yd. on site)

LIME—Warehouse prices:

	Hydrated, per Ton — Finishing	Hydrated, per Ton — Common	Lump, per 200-Lb. Barrel — Finishing	Lump, per 200-Lb. Barrel — Common
New York	$21.00	$19.00	$3.50* - at plant -	$3.30*
Chicago	20.00	....	....	1.75
St. Louis	26.00	20.00	....	2.50*
Boston	25.25	21.25	3.50	3.25
Dallas	27.50	25.00	....	3.00†
Cincinnati	*16.70*	*14.50*	....	**14.50‡**
San Francisco	25.40	22.00	....	2.25
Minneapolis	29.00	22.00 (white)	1.80	1.50
Denver	....	3.20 (bbl.)	1.00 (bu.)	....
Detroit	22.00	19.00	2.00†	1.80†
Seattle	27.00	....	3.25	....
Los Angeles	....	30.00	3.00*	3.00*
Baltimore	22.25	17.50	....	12.75‡
Montreal	30.00	....	15.00‡	....
Atlanta	*21.00*	*17.00*	1.60	**1.50**
New Orleans	....	17.00	2.75	2.00

* 300-lb. barrels. † Per 180-lb. barrel. ‡ Per ton.

NOTE—Refund of 10c. per barrel.

NATURAL CEMENT—Price to dealers for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$1.50
Kansas City (Ft. Scott)	1.60	1.60
New Orleans	3.36	3.36
Atlanta (Magnolia)	11.00 ton	1.90
Cincinnati (Utica)	*1.87*	2.85
Boston (Rosendale)	*2.85*	2.35

PORTLAND CEMENT—Current prices are for barrels in carload lots, *without* bags, to contractors:

	Current Without Bags	One Month Ago Without Bags	One Year Ago Without Bags
New York (delivered)	$2.80	$2.80	$3.30
New York, alongside dock to dealers	2.40	2.40	2.65
Jersey City (delivered)	2.89	2.89	2.47
Boston	2.86	2.86	2.60
Chicago	2.17	2.17	2.15
Pittsburgh	2.17	2.17	2.20
Cleveland	2.43	2.43	2.42
Detroit	2.43	2.43	2.28
Indianapolis	2.43	2.43	2.42
Toledo	2.49	2.49	2.28
Milwaukee	2.39	2.39	2.20
Duluth	2.10	2.10	2.20
Peoria	2.45	2.45	2.32
Cedar Rapids	2.51	2.51	2.40
Davenport	2.47	2.47	2.38
St. Louis	3.00	2.60	3.05
San Francisco	3.09	3.09	2.63
New Orleans	3.36	3.36	2.96
Minneapolis	2.41	2.41	2.22
Denver	3.10	3.10	2.82
Seattle	3.10	3.10	3.03
Dallas	2.60	2.60	2.15
Atlanta	*2.60*	2.75	2.70
Cincinnati	**2.62**	2.57	2.90
Los Angeles	**3.31**	3.21	3.10
Baltimore (del.) drayload lots	3.58	2.58	3.85
Detroit	2.43	2.43	....
Birmingham	3.05	3.05	....
Kansas City	3.20	....	2.56
Montreal	....	3.44	3.48

NOTE—Bags 10c. each, 40c. per bbl.

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH by 4-INCH MESH

Style Number	Weight in Pounds	Pittsburgh, Mill	Chicago	Dallas	San Francisco
032	0.022	$0.87	....	$1.15	$1.38
049	0.028	1.11	....	1.46	1.74
068	0.035	1.35	....	1.80	2.14
093	0.045	1.73	....	2.30	2.75
126	0.057	2.14	....	2.86	3.42
153	0.068	2.55	....	3.40	....
180	0.078	2.93	....	3.93	....
245	0.103	3.86	....	5.15	....
287	0.119	4.46	....	5.96	7.16
336	0.138	5.18	....	7.32	....
395	0.160	6.00	....	8.00	....
		PAVING			
036P	0.017	$0.66	....	$0.88	....
053P	0.024	0.94	....	1.24	....
072P	0.031	1.18	....	1.57	....
097P	0.040	1.52	....	2.02	....
049R	0.024	0.94	....	1.24	....
067R	0.031	1.18	....	1.57	....
089R	0.040	1.52	....	2.02	....

Made in 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52- and 56-in. width in rolls 150-, 200- and 300-ft. lengths. Galvanized is about 10% higher.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27	233	$27.35	$27.50	$29.35	$34.20	$31.55
26	250	29.00	28.90	29.35	.....	33.30
25	300	31.00	31.15	32.00	.....	36.00
24	340	32.90	33.10	33.90	42.70	37.45
22	450	36.05	.....	.....	.....	43.30

*Material shipped from mill, freight allowed, or at warehouse. Delivery charge is 1c. per sq. yd.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb:

ROLLED FROM BILLETS

	Warehouse, Uncut					
Inches	Pittsburgh Mill	New York	Birmingham Mill	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.10	$3.28	$2.35	$3.13	$3.22½	$3.75	$2.35
⅝ and larger	2.15	3.33	2.50	3.17	3.27½	3.80	2.40
¾ and larger	2.20	3.38	2.50	3.23	3.32½	3.85	2.45
⅞ and larger	2.35	3.43	2.50	3.38	3.47½	4.00	2.60
1 and larger	2.60	3.73	2.50	3.83	3.52½	4.45	2.85

*Includes 15c charge for cutting to lengths of 2 ft. and over.

Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ in. and larger	$2.00	$2.25	$4.25	⅝	$2.40	$2.50	$3.40
¾	2.05	2.30	4.30	1	2.40	2.75	3.45
⅞	2.15	2.35	....	.....	....	....	3.50

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common			Paving Block	
	Current	One Month Ago	One Year Ago	3-inch*	4-inch*
New York (del.)	$18.40	$18.40	$33.00	$47.00	$42.50
New York (at dock)	15@15.50	15.00	25.00	.....	.....
Chicago	12.00	12.00	14.00	34.00	.....
St. Louis, salmon	17.00	15.00	16.00	.....	.....
Denver, salmon	14.00	14.00	17.00	.....	.....
Dallas	12.50	16.00	24.00	44.00	.....
San Francisco	18.00	18.00	15.00	.....	44.38
Los Angeles	15.50	15.00	13.50	(not used)	
Boston (del.)	20.00	21.75	32.00	48.50	56.25
Minneapolis (del.)	17.00	18.00	21.00	37.00	43.00
Kansas City	15.50	....	22.00	.....	.....
Seattle	14.00	19.00	15.00	48.00	53.50
Cincinnati	18@20	20.00	24.00	41.50	.....
Montreal (del.)	18.00	18.00	16.00	100.00	120.00
Detroit (del.)	16.25@18	18.00	23.00	41.30	44.00
Baltimore (del.)	25.00	25.00	25.00	40.00‡	44.00‡
Atlanta	11.00	12.00	.....	40.00	.....
New Orleans	14.50	17.50	24.50	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots for hollow building tile:

	New York			St. Louis			Perth Amboy
	Current on Trucks*	One Year Ago	Chicago	building	partition	San Francisco	N. J., Factory
4x12x12	$0.12320	$0.11475	$0.09475	.....	$0.085	$0.145	$.....
6x12x12	.16420	.153	.13740	.....	.085	.21	.....
8x12x12	.219	.204	.16105	.....	.095	.29	.208½
10x12x12	.....	.....	.19790	$2.23	1.26	.....	.2605
12x12x12	.....	.....	.23750	2.66	1.70	.....	.3126

*per. off for cash

	4x12x12	8x12x12	12x12x12
Boston	$0.1107	$0.207	$.286
Minneapolis	.084	.161	.230
Minneapolis (delivered)	.092	.175	.250
Cincinnati	.069	.148	.202
Kansas City	.115	.207	...
Denver	.09	.16	.23
Seattle	.10	.175	.30
Los Angeles factory	.11	.192	.23*
New Orleans	.10	.215	.3750
Detroit (delivered)	.107	.250	.2776
Montreal	.20	.30	.35
Baltimore	.16	.27	.45
Atlanta	.09875	.175	.....
Dallas	.13	....	.....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	New York (del.)	Birmingham	Dallas	St. Louis	Chicago (del.)	San Francisco
Beams, 3 to 15 in.	$2.00@	$2.20	$3.23	$2 20	$4 50	$3 32½	$3 13	$4 35
Channel, 3 to 15 in.	2.00@	2.20	3.23	2.20	4.50	3.32½	3.13	4 35
Angles, 3 to 6 in., ¼ in. thick	2.00@	2.20	3.23	2.20	4.50	3.32½	3.13	4 35
Tees, 3 in. and larger	2.00@	2.20	3.23	2.20	4.50	3.32½	3.13	4 35
Plates	2.00@	2.20	3.23	2.20	4.50	3.32½	3.13	4 50

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

		Warehouse				
	Pittsburgh, Mill	New York — Current	New York — One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.70	$4.65	$6.00	$4.53	$4.97½	$6.00	$5.75

CONE HEAD BOILER

½ in. and larger	3.80	4.75	7.10	4.63	5.07½	6.10	5.90
⅝ and ¾	3.95	4.90	7.25	4.78	5.22½	6.35	6.05
⅞ and 1	4.20	5.15	7.50	5.03	5.47½	6.60	6.30

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00@$3.25	$3.78	$5.25	$5.00	$4.10	$4.95
Cut	.....	6.85	6.28	7.75	4.75	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows at manufacturing points:

	New York			Philadelphia		
	1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.	1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.
No. 1 grade	$2.07	$2.43	$2.85	$1.97	$2.33	$2.75
No. 2 grade	1.77	2.08	2.45	1.67	1.93	2.35

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.80 per roll in carload lots and $3.05 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $7.95 per square in carloads; $8.20 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices per ton f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq. ft.	$2.60
Tar pitch (in 400-lb. bbl.) per 100 lb.	1.95
Asphalt pitch (in barrels) per ton	47.50
Asphalt felt (light) per ton	80.50
Asphalt felt (heavy) per ton	84.50

SHEETS—Quotations are in cents per pound in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.10	$3.97½	$3.88	$6.00	$3.88
No. 12	3.15	4.02½	3.93	6.05	4.93
No. 14	3.20	4.07½	4.08	6.10	4.98
No. 16	3.30	4.17½	4.18	6.20	5.08
Black					
*Nos. 18 and 20	3.85	5.30	4.95	6.80	4.55
*Nos. 22 and 24	3.90	5.35	5.00	6.85	4.60
*No. 26	3.95	5.40	5.05	6.90	4.65
*No. 28	4.00	5.50	5.15	7.00	4.75
Galvanized					
No. 10	4.00	5.25	5.45	...	4 60
No. 12	4.10	5.35	5.55	7.10	4.70
No. 14	4.25	5.35	5.65	7.25	4.85
Nos. 17 to 21	4.40	5.65	5.85	7.40	5.15
Nos 22 and 24	4.55	5.80	6.00	7.55	5 30
*Nos. 25 and 26	4.70	5.95	6.30	7.70	5 45
*No. 28	5.00	6.25	6.40	8.00	5.75

* For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrel (5 bbl.)	$0.80	$1.73	$0.75	$1 78

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	15 50	17 00	13 00	15 50
25- and 50-lb. kegs	13 25	14 75	15 75	17 25	13 25	15 75
12½-lb. keg	13 50	15 00	16 00	17 50	13 50	16 00
5-lb. cans	16 00	17 50	18 50	20 00	16 00	18 50
1-lb. cans	18 00	19 50	20 50	22 00	18 00	20 50

500 lb. lots less 10% discount. 2000 lb. lots less 10-2½% discount.

LUMBER

San Francisco—Prices of rough Douglas fir No. 1 common, in more than carload lots:

	Lumber Prices in Yards at San Francisco			
	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$24 50	$25 00	$26 00	$28 00
3x6 and 8	25 50	26 00	27 00	29 00
4x4-6 and 8	26 00	27 00	28 00	29 50
3x10 and 12	26 00	27 00	28 00	30 00
3x14	26 50	27 50	28 50	30 50
4x10 and 12	26 00	27 00	28 00	30 00
4x14	27 00	28 00	29 00	31 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
10	$25 50	$27 50	$28 50
6x14	27 00	29 00	29 50
8x10	25 50	27 50	28 50
3x14	27 00	29 00	29 50

New York, Chicago and St. Louis

	Southern Pine			
	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x 4 to 8x8	$33 00	$34 00	*$50 00*	*$51 00*
3x10 to 10x10	38 00	39 00	*53 00*	*53 00*
3x12 to 12x12	43 00	44 00	*54 00*	*55 00*
3x14 to 14x14	48 00	49 00	*59 00*	*60 00*
3x16 to 16x16	55 00	56 00	*64 00*	*65 00*
3x18 to 18x18	67 00	68 00	*69 00*	*69 00*
4x20 to 20x20	.....	.....	*71 00*	*72 00*

*Wholesale price (to dealers) of long leaf pine. Short leaf pine up to 14 x 14 costs $15 per M. less.

Price to contractors, on lighters or cars, New York, about $5 additional.

St. Louis: Yellow pine, 22@24 ft. long, 3 x 4 to 4 x 4, $35; 3 x 6 to 8 x 8, $33; 3 x 12 to 5 x 12, $43; 3 x 14 to 4 x 14, $48; 3 x 16 to 4 x 16, $52; 3 x 18 to 5 x 18, $58.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20-Ft and Under				12 x 12-In. 20 Ft. and Under	
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston	$45 00	*$52 00*	$55 00	*$45 00*	$55 00	*$52 00*
Seattle	.....	*20 00*	.....	.....	.....	*20 00*
New Orleans	35 00	.....	.....	.....	38 00	.....
Baltimore	58 00	.....	.....	.....	68 00	.....
Cincinnati	50 00	50 00	.....	.....	65 50	64 00
Montreal	78 00	85 00	68 00	78 00	78 00	100 00
Los Angeles	.....	47 00	46 00	.....	.....	49 00
Detroit	Quotations f.o.b mills only					
Denver	.....	*32 75*	.....	.....	.....	*33 75*
Minneapolis	*42 00*	*37 00*	*33 00*	.....	*49 00*	*37 00*
Atlanta	27 50	.....	.....	.....	*39 00*	.....
Dallas	35 00	.....	.....	.....	40 00	.....
Kansas City	34 00	35 00	.....	.....	39 00	37 00

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir	Hemlock	P.	Fir
Boston	$45 00	*$48 00*	*$37 00*	$43 00	$48 00
Seattle	.....	*15 00*	.....	.....	*17 00*
New Orleans	55 00	.....	.....	35 00	.....
Baltimore	42 50	.....	.....	40 00	.....
Cincinnati	70 00	80 00	.....	40 00	.....
Montreal	120 00	60 00	60 00	80 00	80 00
Los Angeles	.....	41 00	40 00	.....	81 00
Denver	.....	*29 75*	.....	.....	*27 75*
Minneapolis	38 00	*31 25*	*31 25*	36 00	*30 25*
Atlanta	15 00	.....	.....	18 00	.....
Dallas	.....	30 00	.....	35 00	.....
Kansas City	36 00	30 00	.....	.....	31 00

*Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Dimension and form lumber delivered on building site, $26@$28. For 8x8x20 and smaller, 85 per cent heart, $33; 12x12x20 and smaller, 85 per cent heart, $42; 1x10x16 and smaller, rough, $16; 2x10x16 t. and g., $22; f.o.b. mill.

Detroit—General quotations not available. Rough fir, 2 x 12 and 2 x 4, by 16 ft., $44; 3 x 12 x 16 ft., $48; 2 x 4 x 16, $42.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.33½	Detroit	$0.33
Birmingham	76½	Kansas City	.81½
Boston	.41½	New Orleans	.51½
Buffalo	.29½	New York	.38
Chicago	.38	Pacific Coast (all rail)	1.66½†
Cincinnati	.33	Philadelphia	.35
Cleveland	.24	St. Louis	.47½
Denver	1.35*	St. Paul	.69½

Note—Add 3% transportation tax. * Minimum carload, 40,000 lb. Minimum carload, 50,000 lb., structural steel only; 80,000 lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEET PILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2.55	$2.55	$2.55@$3.65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	New York
Hercules red strand, all constructions	20%
Patent flattened strand, special and cast steel	20%
Patent flattened strand, iron rope	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	22½%
Iron strand and iron tiller	5%
Galvanized iron rigging and guy rope	+12½%

San Francisco: Galvanized iron rigging and guy ropes +17½%; bright plow, 30% off.

Chicago: Plow steel, round strand, 30% off; flattened strand, 15%; cast steel, round strand, 17½%.

Western and California territory, 30% plow steel; +17½% galvanized iron rigging and guy rope.

Montana, Idaho and Arizona, 25% plow steel; +22½% galvanized iron rigging and guy rope.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft. there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ½-in., 8 ft., ⅝-in., 6; ¾-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ½-in. and larger, in 1200-ft. coils:

Boston	$0.20	New Orleans	.18½
New York	.16½	Los Angeles	.16½
Chicago	.18	Seattle	.16
Minneapolis	.17½	St. Louis	.17½
San Francisco	.15	Montreal	.30
Atlanta	.19	Detroit	.18
Denver	.21½	Baltimore	.25
Cincinnati	.22	Kansas City	.16½
Dallas	.29		

*780-ft. coils.

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin	
	40%	60%
New York	$0.31	$0.345
Boston	.24	.275
Kansas City	.2485	.2745
Seattle	.20	.235
Chicago	.2425	.2675
Minneapolis	.2299	.2555
St. Louis	.28	.315
Denver	.2375	.2725
Dallas	.29	.375
Los Angeles	.25	.29
Atlanta	.2875	.3225
Baltimore	.2875	.3175
Cincinnati	.2625	.2875
Montreal	.32	.37
Bizmingham, *delivered*	.1925	.2275

PILES—For spruce and plain pine piles, delivered New York, the price is as follows:

Spruce 10-in. butts, 5-in. tops, length 20-30 ft.	$11 50
Spruce 12-in. butts, 6-in. tops, length 30-40 ft.	10 50
Pine 12-in. butts, 6-in. tops, length 41-50 ft.	13 75
Pine 14-in. butts, 6-in. tops, length 51-60 ft.	22 50
Pine 14-in. butts, 6-in. tops, length 61-71 ft.	25 25

Dallas		St. Louis	
6-in. x 20-ft.	$4.60	6-in. x 30-ft.	$7.90
		7-in. x 30-ft.	10.10
6-in. x 30-ft.	7.10	7-in. x 35-ft.	15.55
		8-in. x 35-ft.	16.55
8-in. x 30-ft.	8.45	7-in. x 40-ft.	16.05
		8-in. x 45-ft.	27.05
8-in. x 35-ft.	10.38	8-in. x 50-ft.	28.05

SCRAP—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$10.50	$11 00	$11.00
Stove plate	*9.50*	14 00	11.50
No. 1 machinery cast	17.50	15 00	*14.00*
Machine shop turnings	*3.00*	*4.00*	5.00
Cast borings	*3.75*	*6.00*	7.00
Railroad malleable cast	8.50	14 00	12.50
Re-rolling rails	10.00	13.00	*12.00*
Relaying rails	*40.00*	*30.00*	*27.00*

SHIP SPIKES—Current prices per 100 lb.

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$9.10	$8.40	$8.55
⅝	8.65	6.65	8.25
¾	8.50	6.50	8.30

Pittsburgh base, $3.25@$3.40 per 100 lb.